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AUTHOR Cairns, George F.; Butterfield, Earl C.
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ABSTRACT

The third of four documents reviews research on assessment in three domains (receptive language skills, expressive language skills, and perceptual and cognitive processes) as the most likely to predict subsequent language development of young children who have yet to speak their first word. Section II focuses on assessment of hearing sensitivity and speech perception, two factors that permit receptive language. Among conclusions of a third section on productive language skills are that screening is the least sophisticated assessment function; that diagnostic tests must identify a handicapping condition and indicate a treatment; and that tracking behavioral change is the most sophisticated function of assessment and is presently impossible. It is concluded in Section IV that perhaps the only immediately applicable assessment procedure used to study the cognitive and perceptual underpinnings of language is the Piagetian scale developed by J. Uzgiris and J. Hunt. Among recommendations offered in a final section are that the Bureau of Education for the Handicapped support only research whose procedures yield data that would support clinical decisions about individual infants and that support be given to more narrowly circumscribed research efforts in each of the three areas (receptive language, expressive language, and perceptual and cognitive processes) reviewed. (SBH)

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Assessing Language-Related Skills of Pre-linguistic Children

FINAL REPORT - VOLUME III

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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George F. Cairns and Earl C. Butterfield

R. L. Smith Mental Retardation Research Center

University of Kansas Medical Center

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Final report on subcontracted portion of Assessment of Language Training for Preschool Handicapped Children, a project of the Bureau of Education for the Handicapped.

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I. Introduction

Throughout this review the term pre-linguistic is used to refer to children who have yet to speak their first word. For the vast majority of people, the pre-linguistic period lasts less than two years. When it lasts much longer, the odds are very high that a child will never acquire normal mature language. Significant delays in speaking and subsequent language deficits are associated with many conditions including deafness, aphasia, mental retardation and cerebral palsy (Telford & Sawrey, 1967). A few of these conditions are apparent in early infancy and can be used as criteria for placing children in programs that are aimed at preventing language impairments by providing special training very early in life. Thus, intervention programs have been designed for infants born with Down's syndrome (Bricker & Bricker, 1974) and for infants whose mothers or fathers are mildly retarded (Ramey, Collier, Sparling, Loda, Campbell, Ingram, 1974). But many children who will not develop normal language have no associated conditions to signal that fact early in their lives, and not all of those infants who are at risk by such criteria as their parents' low intellectual levels will in fact develop poorly. For both of these groups, the aspiring preventer of language deficits would like to have some direct assessment to signal which infants need preventive programming.

Such predictive indices are needed not only to decide who should be served by language intervention programs, but also to assess the value of those programs. An associated condition, like Down's syndrome, is fine for identifying a child in need, but monitoring that syndrome is obviously useless for the purpose of determining whether the preventive training is fostering better than expected language development. To assess the success of language training programs, we need direct measures of behaviors that predict later language behavior. This is particularly true for pre-linguistic

children. Since they have no speech, changes in their talking cannot be used to index how they are responding to training. Effective assessment devices are thus essential to the design and evaluation of language training programs.

What should one assess in order to predict subsequent language development and to monitor how pre-linguistic children are progressing toward normal language use? If there were a satisfactorily complete theory of language development, then one could look to it for a specification of relevant factors to assess. Since there is no such theory, we must be guided by empirical considerations. In effect, we must seek factors that are measurable during the pre-linguistic period of development and which predict subsequent language use. Indeed, our purpose has been to discover whether there are any such factors. We considered measures from three domains as the most likely to predict subsequent language development. The domains were receptive language skills, expressive language skills, and perceptual and cognitive processes upon which language might be built. The remainder of this introduction gives our reasons for slicing the matter into these three segments.

Our decision to consider perceptual and conceptual factors that might underlie language development separately from our considerations of receptive and expressive language skills acknowledges the fact that students of language development have reached an important new consensus. It is that language depends upon and could not develop without prior cognitive and perceptual growth (Bloom, 1970, 1974; Bowerman, 1973; Brown, 1973; E. Clark, 1973; H. Clark, 1973; Lenneberg, 1971; MacNamara, 1972; Premack & Premack, 1974; Schlesinger, 1971; 1974; Sinclair-deZwart, 1971, 1973; Slobin, 1973). Thus, Slobin argued that "the pacesetter in linguistic growth is the child's cognitive growth (1973, p. 194)." MacNamara's premise is that "when infants

begin to learn language, their thought is more developed than their language (1972, p. 3)." Premack and Premack assert that language can be viewed as a map of existing perceptual and cognitive distinctions and that "if certain perceptual and conceptual abilities are not present, language cannot be acquired at all (1974, p. 18)." Our question was whether any perceptual or conceptual skills of the pre-linguistic child have been shown to predict subsequent language development. We wanted to know whether this new consensus had shown itself in research upon which practicioners might draw to determine whether a child needed special non-linguistic training to permit him to benefit from special linguistic training.

The distinction between receptive and productive language skills followed from the fact that children respond appropriately to language forms well before they consistently produce those forms correctly themselves. The generalization of this fact to receptive behavior during the pre-linguistic period is straight forward. There is little doubt in anyone's mind that children comprehend some spoken language before they produce any. Our question was about the receptive processes that allow this comprehension. Thus, we focused on sensory and perceptual capabilities for speech stimuli. We sought information about whether assessments of receptive language capabilities of pre-linguistic infants predict their subsequent language use.

Our decision to look at vocal expressive behavior during the pre-linguistic period amounts to a generalization of the notion that skills which develop relatively late are built upon ones developed earlier. The hypothesis that we chose to evaluate was whether there was any solid evidence for or against the idea that subsequent language difficulties could be predicted from characteristics of pre-linguistic vocal behavior.

This portion of the report, which concerns pre-linguistic assessment of factors that might be related to subsequent language development, has four

sections. The first three review in turn, information on receptive skills, expressive skills and perceptual-cognitive skills. The fourth section translates the material covered in the first three into recommendations to the Bureau of Education for the Handicapped. The purpose of this concluding section is to identify actions that will facilitate evaluation of the effectiveness of language intervention programs directed at pre-linguistic populations. The purpose of such evaluation is to provide sound bases for deciding whether and how to revise language training routines.

II. Assessing Factors that Affect Receptive Language Functioning

In order to comprehend spoken language, a child must hear speech, perceive its elements, combine the elements according to the phonological and syntactic rules of his language, and associate the resulting derived input with appropriate meanings. (Undoubtedly, he must do other things too, but from the assessment viewpoints, these four are a handful). Our focus on the earliest stages of development, before the child speaks, suggests that we should attend primarily to whether the child hears and to his perception of the elements of speech. Assessing mastery of phonological and syntactic rules among pre-linguistic children is still more a goal than a reality, and its realization will probably have to await thorough exploration of the child's discrimination and classification of the phonetic elements of speech. Accordingly, our consideration of assessing receptive language deals first with measuring hearing sensitivity, then with speech perception, and then briefly with comprehension. A more extended treatment of measuring comprehension is provided in the section on the assessment of linguistic skills (See section by Longhurst). These three considerations draw on the experimental literature.

A. Hearing Sensitivity

It is now possible to efficiently and economically assess the hearing sensitivity of normal infants who are 6 months or older (Lloyd, 1976; Wilson,

1976). That is, something approximating absolute thresholds for pure tones can be assessed within one or two sessions of less than an hour. Wilson (1976) describes the ways in which this can be done. Generally speaking, it is a matter of operant conditioning, but the arrangements by which the conditioning is effected are best described as game like.

It is also possible to assess the hearing sensitivity of profoundly retarded people who have no expressive language (Fulton, 1974). Again, operant conditioning is required. So far, the procedures used with severely handicapped children have not been made game-like, and this might acount for the fact that the time required to assess their thresholds is substantially longer than for normal children (Lloyd, 1976). There is a need for additional procedural experimentation to determine whether the procedures for severely handicapped children can be shortened. The model for this sort of work is contained in Wilson's (1976) approach to normal infants.

There are a variety of techniques that do not require the conditioning of motor responses, and which can be used from very near birth. The simplest of these procedures is impedance audiometry. It can assess threshold values and assess the status of inner ear mechanisms (Jerger, 1975; Keith, 1973, 1975; Margolis and Popelka, 1975). Completing this procedure takes only a matter of minutes and requires hardly any behavioral cooperation. This makes the impedance technique clinically preferable to the various evoked brain responses techniques (e.g., Hecox & Galambos, 1974). The disadvantage of the impedance procedure is conceptual; it does not establish whether the child can act on what his ear senses. This limit also applies to the evoked-response procedures. Perhaps the greatest challenge for the future of assessment of pure tone thresholds is to devise variants on operant procedures that will allow assessment at or near birth.

B. Speech Perception

Assessing pure tone thresholds is only the barest beginning of determining whether a pre-linguistic infant's auditory functioning can support receptive language. Speech is not composed of pure tones, and perhaps the best way to appreciate the magnitude of the assessment challenges facing those who wish to determine how pre-verbal children process speech is to consider its acoustic properties. Spoken English has been analysed intensively with both spectographic and oscillographic techniques. Several cues isolated by such analyses have been mechanically synthesized and built into speech-like stimuli. Even though such synthetic stimuli seldom sound like natural speech, English adults discriminate and classify them phonetically. Such analytic and synthetic procedures have revealed acoustic variables that are sufficient for phonetic perception. But acoustic analysis and synthesis have revealed only a few invariant correlates of the linguistic features of our language. Instead of invariance, they have shown, first, acoustic cues which can signal different phonetic messages in different linguistic contexts. For example, cues which are sufficient to signal /b/ in one context, signal /p/ in another. They have also shown different cues which can signal the same phonetic message in different contexts. Thus, the perception of /d/ can be signalled by one set of cues in some acoustic environments, and by a completely different set in other environments. Such contextually-conditioned variation seems the rule for phonetic elements of speech: acoustic invariance is the exception.

Acoustic studies of speech have also found that cues for several different phonetic segments can be coded in a single part of the signal. Thus, cues for the initial /b/ and for the terminal /g/ are both carried on the same portion of the acoustic signal which also carries the middle /a/ for the word "bag". As a result of such spillover from neighboring segments,

phonetic boundaries are nearly impossible to find in the speech signal. Moreover, this complex coding seems not to be achieved by any kind of multiplexing, through which the neighboring carrier segment might be readily discerned. Instead, the coding of adjacent segments onto a phonetic element can cause changes in what seems its basic nature. Simultaneously-multiple, complexly-interacting codes seem the rule in speech: singular, transparent codes are the exception. All of this should spell perceptual difficulty early in life. It suggests that speech perception should develop and that assessing an infant's developmental level with respect to speech perception will be relevant to knowing whether he can acquire receptive language. It also suggests that assessing speech perception will require great attention to the stimulus materials used.

The phonetic features of speech are not conveyed directly. They are indirectly cued by acoustic variations. But not every acoustic variation in the speech signal has phonetic significance. We can usually judge a speaker's mood, age, sex and sometimes his unique identity from his speech, but when we can't judge any of these things, we may still perceive his phonetic message. So we must ask about the particular acoustic properties of stimuli used to test infants' speech perception: Could the stimuli have been discriminated acoustically as if they had contained no phonetic cues? It is presently impossible to answer this question with certainty. No study that has used natural speech stimuli has satisfactorily established that its natural speech tokens are acoustically equal with respect to their non-phonetic features. Indeed, it is not clear that such equality could ever be established with analytic tools that are currently on the market.

To insure that infants respond only to acoustic cues that are correlates of phonetic features some experimenters have used synthetic speech. But since cues for phonetic features are generally complex and multivariate,

the question must arise whether infants discriminate only one acoustic element or the whole phonetically-sufficient synthetic complex. No one knows which nor how many other phonetic cues are absent from synthetic stimuli used in infant experiments. There may be many sets of minimal cues which adults can use to make phonetic discriminations among stop consonants. For example, adults may use burst cues, which usually have not been included in the synthetic stimuli presented to infants, when they discriminate /b/ from /g/ (Fischer-Jorgensen, 1972; Cole & Scott, 1974). Therefore, even if it were shown that infants discriminate some particular set of minimal cues as adults do, that would not eliminate the possibility that they come to discriminate others only much later in life. We know from the study of visual perception that less experience is required for the discrimination of gross stimulus properties than for the development of the ability to discriminate subtle and more abstract stimulus characteristics. We also know that the speech signal is exceedingly rich and complex, and that its acoustic analysis, though extensive, is far from complete. Every analytic effort in the history of science has revealed increasingly specific and more abstract physical properties of its subject matter as it has been pursued longer. And the synthesis of physical properties generally lags behind their analytic discovery. This is true at least in the early phases of any scientific endeavor, and the acoustic analysis of speech is certainly in its early phases. The tape recorder, upon which speech analysis and synthesis are both absolutely dependent, was first built only 30 years ago, and it is still being refined in important ways. It follows that experiments using synthetic stimuli have studied infants' discrimination of gross features of speech, and it is these features that are least likely to differentiate between pre-linguistic infants.

Because of the complex and variable relationships between its acoustic properties and its phonetic significance, studies of speech perception have

necessarily said little about phonetic processing. Nevertheless, there has been a fair amount of research into infants' speech perception that might be instructive for assessment purposes. For example, the research speaks to the question of whether speech and non-speech events are differentially effective stimuli for pre-linguistic infants. One might expect speech to be a particularly salient cue for infants, and if it were not for a particular child, then one should consider him a candidate for language difficulties. What does the literature say on these matters?

Two groups of findings show that speech is an effective part of the infant's environment. Noncontingent speech changes infants' ongoing behavior (Webster, 1969; Simner, 1971). Contingent speech increases infants' response rates (Rheingold, Gewirtz & Ross, 1959; Todd & Palmer, 1968; Routh, 1969; Butterfield & Siperstein, 1972; Cairns & Butterfield, 1975).

Simner (1971) presented newborn cries to some neonates and not to others. Those who received the noncontingent cry cried more often and longer than those who did not. Speech has also been observed to change the ongoing behavior of older infants. Barrett-Goldfarb and Whitehurst (1973) found that one-year olds decreased their rate of vocalizing when recordings of their parents' voices were presented. Moreover, one-year olds showed preferences between their mother's and father's voices, as judged by the duration of their selections of which voice to listen to. The suppression of their own ongoing vocalizations was greater by the voice they preferred. Turnure (1971) found that the voice of an infant's mother produced motor quieting, even when it was distorted, as did the undistorted voice of a stranger. Moreover, nine-month olds were quieted more than either three- or six-month olds. Webster (1969) performed a finer analysis of the suppressing effect of speech upon infants' vocalizations. He presented either vowel or consonant stimuli and observed infants' vocalic and consonantal

productions. Vowels suppressed vocalic behavior, and consonants suppressed consonantal sounds.

In summary, both neonates' and older infants' behavior is changed by noncontingent speech, and the character and degree of the suppression depends upon the age of the infant and upon the character of the speech presented to him.

Butterfield and Siperstein (1972) showed that neonates would both increase and decrease their non-nutritive suck duration, depending upon which response would increase their access to contingent singing voices. Jensen et al. (1975) found similar results with conversational speech. In the same laboratory, Butterfield and Cairns (1974) failed to increase neonates' rate of high amplitude sucking with contingent presentations of computer-generated speech segments intended to sound like "ba" and "pa". Whether this is due to a lack of reinforcing properties of the synthetic stimuli or to problems with the high amplitude suck procedure remains to be determined.

There have been many demonstrations that speech stimuli act as positive reinforcers for older infants. Todd & Palmer (1968), Haugen & McIntire (1972), Rheingold, Gewirtz & Ross (1959) and Weisberg (1963) demonstrated that the rate of infants' vocalizations increases when speech sounds are made contingent upon them. This was true despite the fact, cited above, that noncontingent speech decreases the vocalization rate of infants. Sheppard (1969) increased rates of both vocalization and legkicking with contingent presentations of an infant's mother's voice and blinking lights.

Contingent and noncontingent procedures thus show that both neonates and older infants respond to speech: speech is an effective environmental event for them. How does speech compare to other auditory stimuli?

Simner (1971) found that white noise did not elicit as much crying as another newborn's cry. This was true despite the fact that the moment-to-

moment amplitude of the noise was very similar to that of the recorded cry. Thus, the newborns were apparently reacting to something other than the amplitude of the recorded cry. Simner found in another experiment that neither the cry of a five and one-half month infant nor a synthetically-generated cry induced as much crying in newborn infants as did the presentation of another newborn's cry. Thus, newborns respond more to "speech" sounds that are similar to their own.

The only noncontingent comparison of speech stimuli with older infants was reported by Turnure (1971). She observed that distorted and undistorted mother's voices both reduced the motor activity of children between three and nine months of age. The quieting effect was greater for the older infants, which Turnure interpreted as evidence of increased attention by older infants. Distortion had no observable effect.

Butterfield and Siperstein (1972) found that newborns would change their suck durations in order to increase their access to singing and its instrumental accompaniment. When the voices and instruments were presented separately, the voices produced as great an effect as the combined voices and instruments, while the instruments alone produced no differential behavior (Cairns & Butterfield, 1975). When white noise was made contingent upon suck duration, infants responded so as to turn it off rather than increase it as they did with the voices (Butterfield & Siperstein, 1972). Thus, these investigators showed three points on a neonatal reinforcement continuum: singing voices are positively reinforcing; musical instruments are neutral; white noise is negatively reinforcing.

Haughan and McIntire (1972) attempted to compare the reinforcer effectiveness of speech, food and tactile stimulation upon three- and six-month old infants. For speech reinforcers, they employed adults' imitations of the infants' immediately preceding vocalizations. This form of reward was more

effective than either food or tactile stimulation, but, as the authors point out, the interpretation of the finding is complicated by the possibility that nonimitative speech might not have been as effective as the imitative speech they used. Moreover, there were greater delays in the delivery of food and tactile rewards, and there is no clear way to determine whether the deprivation schedules were the same for the three classes of stimuli.

Friedlander (1968, 1970) has examined the effects of redundancy and meaningfulness of speech samples on preference behavior of infants. His procedure allows the infant to choose between two programs of auditory stimulation, or by leaving a three position switch in the neutral position to receive no stimulation. He has used this procedure to collect listening preference data from infants in their home environments. Although fine-grained analyses have not been performed on data gathered using this technique, several findings seem clear. First, Friedlander (1968) was able to demonstrate that infants from 11-15 months of age would select a recording of the mother's voice with a bright inflection over the mother's voice with a flat inflection. Similarly, he demonstrated that an infant would choose a stranger's voice with bright inflection over his mother's voice with flat inflection. Also, a long message that repeated itself every 240 seconds was progressively selected more over a 20 second sample of the longer message. These results indicate that complex characteristics of the speech stream can control infants' behavior when they are about one year of age. Whether this is true for younger infants is unknown.

There appear to have been no adequate tests of whether infants with or who are likely to develop aberrant language respond less or differently to speech than normal infants.

Only one experiment purports to have studied infants' reactions to phonetic boundaries within the speech stream (Condon & Sander, 1974). It

is unconvincing since it does not deal with the difficulties of identifying boundaries in the acoustic signal, nor does it specify its data collection procedure in a way that anyone could hope to repeat. We do not know whether infants respond to phonetic boundaries within the speech stream.

Given that infants may or may not respond to the boundaries between phonetic units, the question is whether they respond differentially to the character of those units. Practically all of the relevant evidence comes from experiments which use some form of the high amplitude such (HAS) procedure. The results of those experiments using other procedures are entirely consistent with ones considered here (Lasky et al., 1975; Kuhl & Miller, 1975; Moffitt, 1971; Eilers & Minifie, 1975; Fodor et al., 1975; Leavitt & Morse, 1975). In each of the several variants of the HAS procedure, young infants are allowed to suck on a non-nutritive pacifier. Following a brief unreinforced baseline period, a speech stimulus is presented each time the infant emits a high amplitude suck. When the infant's HAS rate falls below an a priori response decrement criterion, he is either shifted to a different contingent stimulus or left to experience the same one. Shift is regarded as the experimental condition and No Shift as the control. The critical question is whether infants in the Shift condition show a greater increase in rate of high amplitude sucking immediately following the decrement than do infants in the No Shift condition. If they do, the conclusion is that the pre- and post-shift stimuli are effectively different.

Table 1 summarizes the findings of experiments that have compared speech stimuli using the HAS procedure. All of these experiments studied infants in the age range of two to four months. All except the Kikiyu infants studied by Streeter were born to English-speaking parents. Table 1 describes the contrasted speech segments in terms of how they are classified by native adult speakers of the language from which they are drawn. Except where indi-

Table 1

Summary of Shift/No Shift Comparisons: The Stimuli They Contrasted; Whether the Stimuli Were Natural or Synthetic; Whether the Shift Effect Was Significant; and the References

	Stimuli Contrasted	Kind of Stimulus	Reference
Consonant contrasts for which the shift effect was significant ($p < .05$)			
1.	ba/pa	Synthetic	Eimas et al. 1971
2.	da/ta	Synthetic	Eimas (1974)
3.	dae/gae	Synthetic	Eimas (1974)
4.	dae/gae	Synthetic	Eimas (1974)
5.	ba/pa	Synthetic	Trehub & Rabinovitch (1972)
6.	ba/pa	Natural	Trehub & Rabinovitch (1972)
7.	da/ta	Natural	Trehub & Rabinovitch (1972)
8.	ba/ga	Synthetic	Morse (1972)
9.	za/ʒa	Natural (Czech)	Trehub (1973a)
10.	aba/apa	Natural	Trehub (1973a)
11.	mapa/pama	Natural	Trehub (1973a)
12.	ba/pa	Synthetic	Streeter (1976)
13.	ra/la	Synthetic	Eimas (1975)
Consonant contrasts for which the shift effect was not significant ($p > .05$)			
14.	atapa/ataba	Natural	Trehub (1973a)
15.	ba/ba pa/pa	Synthetic	Eimas et al. 1971
16.	da/da ta/ta	Synthetic	Eimas (1974)
17.	dae/dae gae/gae	Synthetic	Eimas (1974)
18.	dae/dae gae/gae	Synthetic	Eimas (1974)
19.	ba/ba pa/pa	Synthetic	Streeter (1976)
Vowel contrasts (with significant shift effects)			
20.	a/i	Natural	Trehub (1973b)
21.	i/u	Natural	Trehub (1973b)
22.	pa/pi	Natural	Trehub (1973b)
23.	ta/ti	Natural	Trehub (1973b)
24.	pa/pã	Natural (French)	Trehub (1973a)

cated, the contrasts are phonemic for English. Some of the speech segments were generated by computer, and they are designated synthetic. Others ewere recordings of native speakers, and they are designated natural. All of the studies compared the results of Shift and No Shift conditions. A contrast is called signficant when the Shift group showed a reliably ($p < .05$) greater increase in rate of high amplitude sucking from before until after the point of shift than the No Shift group showed from before until after it met the decrement criterion for which it could have been shifted from one stimulus to another. References to the research reports are included in Table 1.

Table 1 shows 12 significant contrasts between speech segments differing by a single consonant sound. These contrasts included comparisons of both natural and synthetic stimuli, differences in both the first and second of two syllables, and distinctions that do not occur as well as ones that do in the language spoken by the children's parents. The fact that there are also 6 nonsignificant contrasts between consonant sounds does not soften the message of those that are significant. Five of the six nonsignificant contrasts are between synthetic stimuli which adults classify identically and do not discriminate, even though the stimuli are acoustically different from one another. The sixth is of a contrast in the last syllable of natural stimuli with three syllables, and there is question in the mind of the experimenter whether adults could have discriminated them under the conditions of this experiment (Trehub, personal communication). Table 1 also shows five comparisons which indicate that infants respond differently to natural vowel stimuli, both when the vowels are presented in isolation and when they follow a consonant, and regardless of the language from which they come. The conclusion is warranted that speech segments are effectively different for infants in the age range of two to four months. How about younger infants?

In order to explore the role of experience in determining the effective-

ness of speech stimuli for infants, Butterfield and Cairns (1974) conducted an experiment with neonates who averaged about 46 hours of age. They compared two of the synthetic stimuli employed by Eimas (1974) with older infants. The /pa/ and /ba/ stimuli differed with respect to the presence and absence of a single energy transition. The /pa/ contained the transition and the /ba/ did not. The neonates who received the /pa/ first responded significantly more, when shifted to /ba/, than their No Shift control. Infants who received /ba/ first did not respond significantly more, when sifted to /pa/, than their No Shift control. Since there had been no reports of order effects for older infants, the experiment was replicated and the /pa/ to /ba/ group again responded significantly to the shift, but the /ba/ to /pa/ group did not. On the hypothesis that experience with the energy transition unique to /pa/ controlled the differential responsivity of neonates, Butterfield and Cairns correlated the number of stimulus presentations prior to shift with the magnitude of the shift effect for both the /ba/ to /pa/ and the /pa/ to /ba/ groups. This was possible because in the HAS procedure, infants differ with respect to how many sucks they emit prior to the response decrement which provides the occasion to shift. The correlation between the number of pre-shift stimulus presentations and magnitude of change following shift was 60 ($p < .05$) for the /pa/ to /ba/ infants and -.07 ($p > .25$) for the /ba/ to /pa/ infants. There is thus some evidence that experience with speech stimuli conditions their differential effectiveness, but the requisite experience can easily be had during the first days of life. Whether this true for all speech cues is not known.

The experimental literature shows that normal infants respond differentially to speech and non-speech stimuli and that they discriminate among phonetic units. The literature is largely silent on how abnormal infant's behave with respect to speech. There is a clear need for evidence on this

matter, and on the more general question of whether there are individual differences in speech perception among pre-linguistic people. There is also a clear need to study a wider range of speech cues. The science is in the peculiar position of knowing more about the speech perception of lower animals, like chinchillas, than it knows about the speech perception of pre-linguistic human (Kuhl, 1976).

We have concentrated here on experimental procedures for assessing receptive language, because of certain serious limits to the use of standardized developmental scales. While these scales provide reliable estimates of general developmental ability, they do not usefully measure receptive language skills. The reasons are discussed below in connection with the use of developmental scales to measure productive language. Standardized scales are similarly limited for this purpose.

III. Assessing Productive Language Skills

There have been few intensive examinations of the development of vocal behavior during infancy. Basic theoretical biases and profound methodological difficulties have discouraged systematic examination of the development of vocal behavior during the first year of life. The recent establishment of many early enrichment and intervention programs that attempt to prevent developmental delays has been accompanied by the reexamination of infant development. The establishment of the programs has revealed a clear need for new assessment tools to evaluate the effectiveness of intervention routines.

Laboratory-based efforts to examine complex linguistically-related processing in infants have led us to a new conception of infants' interactional capabilities (Cairns and Butterfield, 1975), but the dearth of individually-reliable assessment procedures leaves early interveners in a difficult ethical and methodological quandry. The cost of labeling and mislabeling children

has become a prominent issue (Hobbs, 1975). Simply asserting that earlier intervention is always better is no longer satisfactory. The implicit assumption of no personal cost for the child receiving intervention is now seen as faulty. Similarly, questions about the efficacy of early intervention must be answered.

Resolving these issues will require sensitive assessment procedures. Reaching decisions will be made by default if sensitive procedures are not developed. Our purpose is to outline available procedures for assessing vocal production and to elaborate the relationship of these measures to the general verbal development. Then, we will indicate how assessments might be made so as to solve our present quandries.

A. Theoretical Issues and the Language Game

Perhaps the major bias that has colored researchers' approaches to studying vocal behavior during infancy is the notion that the utterances of infants are "prelinguistic". The word "infant" is derived from the Latin infans meaning "one unable to speak". A recent review of infant assessment (Yang and Bell, 1975) describes infancy as being "commonly conceptualized as the period between birth and the acquisition of language". Thus the basic definitions of infancy prejudge the question of whether the developing infant has language.

Recent advances in the study of infant behavior, particularly studies of infant auditory and speech perception, have resulted in a very different notion about the processing abilities of young infants (Eimas et al. 1971; Morse, 1972, 1974; Butterfield & Cairns, 1976). However, this view regarding infants has not yet been translated into new formulations regarding infant production.

The study of language development has been restricted by monolithic theoretical positions. Two recent papers have described the adverse effects

of this monolithic theoretical posturing on data collection. (Crystal, 1973; Bricker and Bricker, 1974). Both argue that overadherance to a particular theoretical position has severely limited the nature of the data collected by particular investigators and has lead to formulations of issues that are unresolvable. Bricker and Bricker (1974) discuss several pseudo issues that characterize the "language game". We will describe some of these issues and then recast the questions in more useful terms.

Issues in language development flow from one critical question: To what extent does early experience affect infant vocal behavior and later development. The pseudo issue of whether language development is innately determined or experientially determined is a simple restatement of this question. Similarly, the position elaborated by Lenneberg (1967), that early behavior is determined by emerging biological systems is a denial that early experience has much effect on vocal behavior development. Whether there is continuity of discontinuity between early vocal production and later language development is also a restatement of this question. Discontinuity theorists (Jacobson, 1968; McNeill, 1970; Sander, 1969) maintain that both the quality and the quantity of vocal behavior during infancy shows discontinuity with later development. The consensus of theorists who argue from this position is that these discontinuities prove that later development is not closely tied to earlier development. On the other hand, continuity theorists (Mowrer, 1952; Staats, 1971) focus on similarities between infancy and later development. They argue that since there are continuous changes in some aspects of response topography, the same or similar processes affect change during both infancy and later development.

Perhaps the two positions that best exemplify the theoretical extremes are those of Skinner (1957), who has maintained a strong environmentalist position, and Chomsky (1959), who has strongly argued against the importance

of early experience. While both of these theorists and others who later joined their camps have taken strong positions regarding the relative importance of early experience, it is clear that straw men have been erected by members of both camps. Bricker and Bricker have critically examined the utility of the two positions. They note that Chomsky's work points out a paradox that is difficult to explain with learning constructs. The fundamental paradox is that speakers are able to produce and listeners are able to understand sentences they have never heard or produced. How could any amount of early experience account for this fact?

Bricker and Bricker point out that Skinner and other radical behaviorists have not attempted to explain language development using learning constructs. Rather, researchers using the experimental analysis of behavior attempt to describe behavior. As a case in point, Skinner's Verbal Behavior is summarized as a complex statement of the hypothesis that the rules describing verbal behavior will be like existing functional laws, and that rule systems special to verbal behavior will not be necessary. Bricker and Bricker (1974) further point out that terms such as stimulus, response, and reinforcer are unnecessary in this system. The straw men that have been erected by other players in the language game are based on older hypothetico-deductive theories that are not a part of current operant analysis. Bricker and Bricker (1974) argue that some interactional approach will provide the most cogent description of language development. They find the interactional system developed by Piaget to be particularly appropriate.

The infant is certainly not divorced from the biological substrate of his articulators nor from the developing neural processes that control these articulators. Neither is he entirely divorced from the linguistic stimulation that surrounds him during this early period of development. Although there have been several attempts to examine the relative contribution of

experimental and biologically based factors on the development of language we think that this level of analysis is premature. A more appropriate strategy for assessing development during infancy is to ask the practical questions (1) Is there systematic patterning of infant vocal behavior? (2) Do babies who have debilitating problems differ from normally developing infants in their vocal behavior? and (3) Is there some systematic relationship between the infant's utterances and his general articulatory behavior and other competencies?

In order to answer these questions we will briefly summarize what we know about vocal development during the first year of life. Rather than organizing this discussion around the theoretical issues that have clouded unbiased interpretations of the data, we will organize the discussion around procedural and methodological considerations. Classifying studies by: (1) the size of their behavior samples and (2) whether the measure qualitative or quantitative aspects of behavior provides a clear means for examining our current knowledge about the development of vocal behavior during infancy. This classification also reveals differences in research style that are directly related to various theoretical positions.

We have labeled the four categories created by these two binary dimensions as: the Macroqualitative Strategy, the Microqualitative Strategy, the Microquantitative Strategy, and the Macroquantitative Strategy.

B. The Microqualitative Strategy

Most standardized assessment instruments employ the microqualitative strategy. A small sample of behavior is taken under standardized conditions. Usually the presence or absence of particular behaviors is used to index the infant's developmental status, compared to a group of infants his age. The amount of behavior (duration, or rate) or latency of responding is not noted.

Several general scales provide some information about how the perfor-

mance of an individual infant compares with that of a group of infants who are the same age. Several items in these scales measure vocal behavior. Similarly, there are a few scales that measure only the development of communication skills.

Most language development scales use similar items to probe communication capabilities. The vast majority of these are taken from general developmental tests or from cross-sectional and longitudinal studies conducted using the macroqualitative or macroquantitative strategies. Gross and Cohen (1975) and Foakes (1971) tried to list all the skills found by developmental studies and in test items. Foakes constructed a scale of language development from birth to 8 or 10 years. She described the period from birth to first word in five stages (birth to six weeks, six weeks to three months, three to six months, six to nine months, and nine months to one year). She described four aspects of each stage; its characteristics, sound making, intonation, and meaning. She summarized information reflecting a variety of methodologies ranging from measures of fundamental frequency of infant cry to clinical retrospective reports of transitions from crying to whimpering.

Gross and Cohen (1975) also examined a wide variety of sources. They organized infant skills (which they call developmental pinpoints) into functional groups by age of first reported occurrance. Their expressive language checklist contains 52 skills before first word production. While many of the items are very similar, they provide information on particular definitions of the skills along with the age of first or average occurrence.

Both of these descriptions of communicative development during infancy are useful summaries of a broad range of behaviors. However, both suffer the limitations of the microqualitative strategy: great variability in the age at which particular items are passed, and lack of ordinality. These

difficulties are discussed below.

General scales of infant development usually include only enough items to allow a very gross evaluation of an infant's receptive and production skills. However, there is a trend for developmental tests to sample infant communication skills more heavily. The Catteli Scale (1940) has three receptive and three production items before the first word. The Bayley Scales (1969) include 12 receptive and nine production items before first word.

Recently developed scales have been designed specifically to measure communication development during infancy. These tests vary widely in the number of items used to probe the infant's capabilities and in their standardization. Tests such as the Infant Speech and Language Development Scale (Boone, 1965) and the Language Evaluation Scale (Blair, undated) have few items and are not standardized. Two language scales having many items and more adequate standardization are the REP (D'Asaro and John, 1961) and the REEL (Bzoch and League, 1971).

The REP scale lists 18 expressive items prior to first word, which according to it should appear at approximately 36 weeks. There are nine receptive items prior to first word. The items are arranged in monthly levels. The research or test bases for most of the items are noted. Almost all of the test items are derived from general assessment instruments, longitudinal or cross-sectional studies, and clinical reports. The REEL (Receptive-Expressive Emergent Language) test is a more ambitious attempt to assess language development in infancy. Preliminary standardization data are presented with the test's manual. The scale contains 27 receptive and 27 expressive items before first word production. The items are grouped monthly into expressive and receptive scales. There are 3 receptive and 3 expressive items for each month of age. A child must pass two of the three items in order to be given credit for an age level. The test is designed to be admin-

istered to a knowledgeable informant rather than by probing the infant's skills directly.

Even the best scales using the microqualitative strategy have several serious deficiencies. As Foakes (1971) points out "...it would be dangerous to place strict time scales on the emergence of particular happenings". There is great variability in the age of passing particular items. None of these scales has documented item-by-item ordinality. While it is clear that certain skills must be mastered before others (production of CV sounds must preceed production of words with CV's in them) it is also clear that there is no reason to expect an ordinal progression for most of the items, nor is there evidence for such progressions.

The variability in the age at which items are passed and the lack of item ordinality has two adverse consequences. First, the tests are insensitive. Second, since the scales are constructed eclecticially, with no rationale for progression of items, no intervention strategy is indicated by patterns of item success and failure. The best of these instruments may detect gross deviations from normal development, but they yield no differential diagnosis, nor do they suggest any particular intervention.

C. The Macroqualitative Strategy

The primary thrust of research using the macroqualitative strategy is to examine large samples of infants' behavior for the emergence of new behaviors or structures. Much of the work conducted by linguistically-oriented researchers uses this strategy. Summary statements describing the data collected are usually couched in terms of stage theory. Many different stage theories have been proposed.

An example of the ordinal progression proposed by stage theorists is the description outlined by Eisenson and his colleagues (Eisenson, Jeffery, & Irwin, 1963). They note five stages before the emergence of true speech

(Undifferentiated Cry, Differentiated Cry, Babbling, Lallation, and Echolalia). Other theorists have postulated different stages (Berry and Eisenson, 1956; Myklebust, 1957; etc.)

Siegel (1969) has described in a more general way the functional stages that have been postulated by various thecrists. There is an initial stage where an infant's vocalizations are a part of a mass reaction of his body that reflects general reflexive responsitivity to external or internal stimulation. Babbling comes next, and it is frequently defined as vocal play or enjoyable sound production. The major notion here is one of pleasurable and flexible reactivity that evolves into self-generated vocal activity. Infants' vocal behavior progresses from babbling to "more stylized utterances that eventually become words". While other theorists have specified more stages or substages of development, the basic functional progression described by Siegel is representative.

In general, the stage theorist has described the emergence of qualitatively new dimensions of vocal behavior during infancy. These new dimensions of behavior are assumed to reflect some new more complex level of processing. The task of the stage theorist has been to describe the underlying processes effecting this progression. Several process interpretations have been made.

Investigators such as Myklebust (1957) tie vocal behavior development to a loose psychoanalytic stage theory. Lenneberg has summarized the developing vocal repertoire of the infant based primarily on the development of the underlying biological substrate (1967). Several other theorists have attempted to describe the development of infant vocal behavior using learning theory notions (Berry and Eisenson, 1956; Eisenson, Jeffery, & Irwin, 1963; Winitz, 1969). More recently, interactional interpretations have been made applying Piagetian stage theory (Bricker & Bricker, 1974). This seemingly premature speculation regarding processes underlying changes in infant vocal

production has produced much theoretical debate and not much data collection.

Two major classes of data have been collected by investigators using the macroqualitative strategy. First, they have described some effects of early experience on infant vocal behavior. Secondly, they have examined the relationships between early vocal behavior and later development.

Several preliminary reports have described the effects of environmental input on infants' vocal behavior during the babbling period. Weir (1966) reported that by 6½ months Chinese infants had a very different pattern of babbling than did either Russian or American infants. Chinese infants typically produced monosyllabic vowels with large tonal contrasts. American and Russian infants produced mainly reduplicated Consonant-Vowel sequences that had little pitch variation across syllables. Similarly, Menyuk (1968) has observed that by the ninth month Japanese and American infants' babbling sounds reflect their respective language environments. Fry (1966) has noted that babbling will follow its normal course in a deaf infant who is fitted with an aid. If the infant is not fitted with an aid the babbling behavior drops out and the infant becomes progressively more silent. These two lines of evidence indicate that the infant's vocal behavior is affected by environmental factors before the production of the first word. However, the relationship between this early vocal behavior and later development is still not clear.

Babbling is a universally described stage of vocal development. It is frequently defined as vocal play or enjoyable sound production. Theorists using the macroqualitative strategy have frequently argued that there is a clear discontinuity between infants' babbling behavior and behavior after the first word. Two kinds of evidence seem to support this view. At first, the infant produces many sounds that are not seen in his mother tongue, but later he begins to utter words and many of these sounds disappear never to

return or only to return at a much later time (Erwin-Tripp, 1966). A similar point is made by Jakobsen (1968), and by Sander (1965). McNeill (1970) notes that the progression of the development of sound production during infancy changes sharply when words are produced. During the first year, consonant-like sounds progress from being produced in the back of the mouth to being produced in the front. Vowel-like sounds progress from the front to the back of the mouth. The direction of development after first word is exactly opposite. Therefore, McNeil argues that the developmental trends during the first year of life are very unlike those during the second year.

The second kind of evidence suggesting discontinuity between infant productions and later development is a change in the quantity of infant productions between the babbling period and the emergence of the infant's first words. Data that have been gathered using both the macroqualitative and the macroquantitative strategies describe this period. Bever (1961) cited in McNeill (1970) reanalyzed some of the phonetic data collected by Irwin and his collaborators. Bever found discontinuities at 4 and 11 or 12 months that bracket the babbling period. At both 4 and 12 months the rate of change of phonetic types drops dramatically. Bever argues that these two discontinuities reflect phases in neurological maturation.

Similar drops in vocal rates between babbling and word production were noted by Tischler (1957) and Roe (1975). Tischler found that frequency of vocalization peaked at 8 or 10 months of age and then declined. Roe (1975) examined the changes in the amount of neutral talking for individual infants in a longitudinal study. She found that individual infants' activity peaked about 9 months of age and then declined.

Other investigators have stressed the continuity between early vocal behavior and linguistic behavior. Mowrer (1952) and Staats (1971) have argued that infants develop a phonemic system by matching the sounds that

they hear to those that they produce. While various processes have been proposed to account for this matching (such as classical conditioning and imitation), these theorists have stressed the similarity of learning processes between infancy and later development. But they have not examined the development of vocal behavior longitudinally. Rather, they have used data primarily gathered using the microquantitative strategy (discussed below) to demonstrate that such processes could account for development.

An intermediate position has been advocated by Brown (1958). He acknowledged that infants produce many more sounds than exist in their particular language community, but has argued that babbling drifts towards the language group of the community because of imitation, selective reinforcement, and secondary reinforcement.

In summary, no one has clearly described the relationship between early vocal behavior and the development of language that follows. To the best of our knowledge no one has even attempted to conduct the appropriate direct test of the hypothesis that there is a relationship between babbling behavior and verbal behavior after first word. There has been no longitudinal experiment with individually reliable procedures that covers both the age of babbling and the age of early language development.

While the macroqualitative approach has not been particularly helpful in describing the relationship between early vocal behavior and later language development, it has provided important information for early assessment. First, it has produced descriptions of the general trends of vocal production during infancy. These data have had particular importance for the development of the standardized tests to assess language competancies during infancy (see section on the microqualitative strategy).

This approach has also made important methodological contributions. First, it has shown the value of examining large amounts of infants' behavior

(in the case of the diary study, essentially all of the infants' behavior is monitored by the parent diarists). It has shown that unconstrained observation settings have the great value of providing a broad picture of the infant's repertoire. Until recently, the people who performed these investigations have been the most sophisticated transcribers of infant productions. Thus, this methodology has offered a broad probe of infants' production competencies. However, there are profound difficulties using these methods alone. There has been little attempt by investigators using the macroqualitative strategy to perform reliability checks. Often there is only the observer. Similarly, the loose sampling methods that may provide better evidence about the richness of the infant's utterances may also mask systematic changes because of sampling bias. There are some recent attempts to study development using these techniques that attempt to control for these biases. These attempts will be discussed later.

D. The Microquantitative Strategy

Most microquantitative research has probed the effects of contingent or noncontingent stimuli on the infants' vocalizations. These experiments have shown whether infants' behavior is reactive to specified environmental changes. Most microquantitative experiments are manipulative. They do not simply observe the infant's ongoing behavior, rather they change the environment and examine the behavioral consequences. Microquantitative experiments have typically used stringent control and reliability assessment procedures, more stringent than either the micro- or macro-qualitative strategies. Similarly, the experimental settings have often been specified more fully than is typical of these other two strategies.

Young infant's vocal behavior is affected by noncontingent events. Even newborns' vocal behavior is affected by noncontingent stimulation. Simner (1971) presented recorded newborn crys to some neonates and not to others.

Those who received the noncontingent cry cried more often and longer than those who did not. Also, another newborn cry had greater effect than either the cry of a 5½ month-old infant or a synthetic cry.

Older infants' vocal behavior is suppressed by noncontingent presentations of speech-related and other acoustic stimuli. Barrett-Goldfarb and Whitehurst (1973) found that one-year olds decreased their rate of vocalization when recordings of their parent's voices were presented. Moreover, one-year-olds showed preferences between their mother's and their father's voices. Webster (1969) performed a finer analysis of the effect of speech on infants' vocalizations. He presented either vowel or consonant stimuli and observed infants' vocalic and consonantal productions. Vowels suppressed vocalic behavior and consonants suppressed consonantal sounds.

Webster and his colleagues (Webster, Steinhardt, and Senter, 1972) also examined the effect of high- and low-pitch vowel sounds on 7-month-old infants. They found a significant increase in the fundamental frequency from baseline to high-pitch stimulus periods but did not find a decrease in infant fundamental frequency from baseline to low-pitch stimulus periods. They also found fewer vocalizations during the high-pitch period than during either baseline of poststimulation periods.

Other sounds also affect vocal behavior. A low-frequency tone is a more effective inhibitor of crying than a high-frequency tone (Birns et al. 1965). Similarly, infants decrease their vocal behavior when presented with a loud bicycle bell (Bench, 1969). Bench (1969) presented groups of babies with either low or high frequency tones or bands of noise. He found that the low frequency tones suppressed crying more than high frequency tones. High band noise tended to be a less effective suppressant than low band noise.

An intriguing example of imitation has also been reported. Sweeny (1973)

studied one 6 week-old baby girl. For one week, the infant spent about 4 hours a day looking at and listening to a pair of finches. On the fourth day, the infant began to make high pitched shrieks similar to the bird calls. The infant's productions of these shrieks continued for several days after the birds were taken away. Long term followup revealed that the infant's speech development was normal and that the shrieking quit. While there is a vast literature on imitation with older children, this is the only study that reports vocal imitation so early in life.

Several investigators have compared acoustic and nonacoustic stimuli to speech stimuli. Dodd (1972) examined the effects of vocal stimulation (14 consonant phonemes and 2 non-speech sounds uttered by an adult), social-vocal stimulation (same sounds uttered by an adult holding the infant) and social stimulation alone. Only infants who received the social-vocal stimulation showed more and longer utterances containing consonants.

A nonmanipulative study by Jones and Moss (1971) found that, at two weeks of age, infant's vocalizations were related to the amount of mother's speech. At three months of age, infants' productions were positively related to the amount mother's speech that had followed infant vocalization, showing that infant vocal behavior is sensitive to its ongoing vocal environment.

One procedure is difficult to classify, but it fits best under the microquantitative category. Delayed auditory feedback involves playing back an infant's vocalizations either immediately or after a short delay (usually less than one second). This procedure has been used to study the development of auditory monitoring by infants. Theorists such as Fry (1966) have suggested that auditory feedback is important for the development of speech in deaf infants. Belmore, Kewley-Port, Mobley, and Goodman, (1973) studied the development of auditory monitoring with two groups of infants. One group (n=11) was between six and 10 months old; the second group was between 12

and 19 months of age. They also grouped the infants according to their linguistic development. Delayed auditory feedback of 200 msec significantly affected either the duration or the intensity of utterances for 13 out of the 28 infants. While the effects of DAF did not vary with age, they did vary with linguistic development. There were significantly fewer changes in utterance duration for infants at the lowest linguistic level than for the children at the two higher levels. Also, infants at the highest level of language development were more likely to have a different intensity level than infants in the lower two groups.

Delayed auditory feedback has also been studied with newborn infants. Cullen, Fargo, Chase, and Baker (1968) examined simultaneous and 200 msec DAF. They found that DAF had a significant effect on cry duration and maximum amplitude, but did not affect pause times. The infants decreased their crying bursts by more than 100 msec under the DAF test conditions.

Infant vocal behavior is also affected by changes in visual stimulation. Shultz and Zigler (1970) found that young infants vocalized earlier in a test session with a stationary test stimulus than with a moving one. Also, they decreased their rate of vocalization from one session to the next. They described these changes in responsivity using Piagetian notions of assimilation and a satiation notion.

These findings all suggest that infants' vocal behavior is affected by noncontingent environmental changes. Similar reactivity is found when infants' vocal behavior is consequated. There have been many demonstrations that speech stimuli act as positive reinforcers for older infants. Todd and Palmer (1968), Haugan and McIntire (1972), Rheingold et al. (1959), and Weisberg (1963) demonstrated that the rate of infants' vocalizations increases when speech sounds are made contingent upon them. This was true despite the fact, cited above, that noncontingent speech decreases the vocalization rate

of infants. Sheppard (1969) increased rates of both vocalization and leg kicking with contingent presentations of an infant's mother's voice and blinking lights. In addition, vocalization seems to act like other operant responses. Sheppard (1969) found that the rate of vocalization of a two-month-old infant was higher under partial reinforcement (FR3) than under continuous reinforcement conditions.

Tomlinson-Keasey (1972) tested 12, 3 month-old infants, using a bell and light as reinforcers. Infants received either the mother's voice or the 500 Hz tone as a discriminative stimulus. Five second discriminative stimulus periods were randomly interspersed with five second stimulus-off periods, during which reinforcement would not be delivered. Difference scores were computed for the five minute periods: the number of vocalizations during stimulus-off periods were subtracted from the number of responses during the stimulus-on periods. Tomlinson-Keasey found that both experimental groups' difference scores were significantly higher during the last five minutes of training than during a five minute baseline period. These two studies both suggest that infant vocal behavior can be brought under stimulus control.

Fouts (1974) has provided evidence that vocal behavior may function as a component in a behavioral chain. He tested a 19 week-old infant who was fed every 4 hours. The infant cried 10 minutes before each scheduled feeding. Examination showed that the infant turned from his stomach to his back just before he began to cry. Accordingly, the father was instructed to keep the infant on his stomach before the 4 a.m. feeding until the infant was quiet for 30 seconds. Such response prevention feedings were contrasted with days without either response prevention or the 4 a.m. feeding. Response prevention resulted in less crying than the "extinction" days.

Raymey and Ourth (1971) examined the effects of delay of reinforcement.

They found that 3-, 6-, and 9-month old infants would increase their rate of vocalizing when social reinforcement was presented immediately following a response. However, the infants who had reinforcement delayed by 3 or 6 seconds showed no evidence of learning. They found no developmental trends.

Response differentiation has also been examined. Routh (1969) selectively reinforced consonant sounds for one group of infants and vowel sounds for a second group. He found significant response differentiation.

The problem of separating the specific effects of contingencies on vocal behavior from the general activating effects of stimulation has been examined by Bloom and her colleagues (Bloom and Esposito, 1975; Bloom, 1975). They found that both response independent and response dependent social stimulation produced increased rates of infant vocalizations. Bloom and Esposito (1975) conducted two experiments. In the first, eight 3 month-old infants received response contingent social stimulation (experimenter smiling, touching the infant's abdomen, and saying "tsk, tsk, tsk") and another eight infants received the same social stimulation independent of their behavior. Both groups' vocalization rates increased from baseline to stimulation periods, and both groups decreased from stimulation to extinction periods. In the second experiment, 12 3-month-old infants received continuous social stimulation for one phase and then received an omission treatment phase where a vocalization produced the withholding of the social stimulation for 5 seconds. These two phases were counterbalanced. They were followed by a third phase where no social stimulation was presented, but where a mobile was suspended above the infant's crib with no experimenter present. Response rates were similar for the first two phases, but responding decreased when the social stimulation was removed in the third phase.

In a second study Bloom (1975) examined which aspects of social stimulation were effective in eliciting vocal behavior. Four 3 month-old infants

were studied. Again, both response independent and response dependent stimulation increased rate of vocalization. However, vocalization increased only when the infants could see the eyes of the adult who delivered the social stimulation.

The implication of these studies is that some form of yoked control is necessary if completely unequivocal interpretations of increased rate of responding is to be made. Yoked, or similar controls with approximately the same density of stimulation, in approximately the same temporal distribution, has seldom been attempted. Two notable exceptions are the experiments by Weisberg (1963) and Sheppard (1969). Weisberg (1963) compared the effects of both contingent and non-contingent social and non-social stimulation on three month-old vocal behavior. Subjects who received social stimulation (E smiled, rubbed infant's chin, and said "yeah") contingent on their vocal behavior increased their rate significantly over the baseline period. Subjects who received the same social stimulation delivered randomly, four times a minute, did not increase their rate of responding. In the 34th and 35th sessions of Sheppard's (1969) extensive experiment with a single infant, a multiple schedule (MULT FR3 NONCONT REIN) was used. During these two sessions, a red light was associated with the FR3 component and no light was associated with the noncontingent component. During the noncontingent phase the reinforcement was programmed once every ten seconds. This schedule did not generate differential responding.

Although there is question about the adequacy of the control groups in all of the studies using social consequences for vocal behavior, these several lines of evidence indicate that vocal behavior may behave as an operant.

The research using the microquantitative strategy has important implications for early assessment. This research shows that the infant's vocal

behavior can be manipulated by environmental arrangements. This fact has two important implications. First, vocal behavior may be used as a means of testing the infants' sensory capacities; vocalization can be treated as an operant in discrimination learning paradigms. Second, since vocalization is under environmental control, environmental factors may influence early productions. Manipulating vocal productions may ultimately be useful for examining infants' early linguistic or prelinguistic capabilities.

E. The Macroquantitative Strategy

The macroquantitative strategy has developed mostly during the past five years. Two examples of it are the criterion reference testing literature and its subgroups domain reference testing (Hively, 1974) and precision teaching (Pennypacker, Koenig, & Lindsley, 1972). Perhaps its only necessary theoretical concept is the notion of the response class: A group of responses that covary in some fashion. The responses may covary as the child gets older, or they may be similarly affected by environmental manipulations. The notion is similar to that of a trait, but the only goal of the macroquantitative strategy is to map the relationships between a group of observable behaviors (the response class). Perhaps the primary assumption of the macroquantitative strategy is that a single behavior or a small group of behaviors reflects changes in the response class as a whole. This, of course, is the assumption underlying all sampling strategies. We call the sampled behavior an indicator response. Others use labels such as pinpoint (Pennypacker, et al. 1972).

The most massive study of infant vocalizations using this strategy was made by Irwin and his colleagues at the University of Iowa (Irwin, 1947a; 1947b; 1949; Irwin and Chen, 1941; 1946; etc.). Their pioneering work revealed systematic changes in both the quality and quantity of infant productions during the first 24 months of life. However, Irwin's findings were presented as group averages. It is effectively impossible to extract devel-

opmental trends for individual infants from the published averages. We have tried to obtain the original protocols in order to determine whether the developmental patterns evident for groups of infants are individually reliable, but protocols are no longer available (the original data were collected about 35 years ago). Nevertheless, Irwin has shown that systematic changes in vocal behavior occur during infancy, and that these systematic changes can be detected in relatively few and relatively short behavioral samples.

Since Irwin, few longitudinal data have been collected on the normal development of vocal behavior during infancy. Little is known about how infants at-risk for language dysfunction differ from normal infants. Perhaps the most widely cited comparison of normally developing infants with at-risk infants was performed by Lenneberg, Rebelsky, and Nichols (1965). They observed the vocal behavior of 10 normal infants and 6 infants of deaf parents. One of the 6 was hearing impaired. Using a tape recorder activated by vocal activity, Lenneberg et al. obtained samples of the infant vocalizations approximately once every two weeks from about two weeks of age until three months of age. Comparisons of a number of different classes of vocalizations for the different infants were made. In discussing this work, Lenneberg (1964) concluded that "neither deafness nor deaf parents reduces the sound activity during the first six months to any appreciable extent." There are many methodological problems with this study. We refer you to the critique by Winitz (1969). Even discounting these critiques, Lenneberg's conclusion is premature. A few data points from a single deaf infant cannot support such sweeping generalizations.

Marya Mavilya (1969; 1972) has collected additional information about the vocal behavior of deaf and normally hearing infants. Mavilya studied the longitudinal development of three hearing impaired infants were taken between 12 and 26 weeks of age. She also obtained samples for the normally hearing

infant over roughly the same age span. While she performed a broad phonetic transcription of the infants' vocalizations similar to that of Irwin, she also performed a more global analysis of the vocalizations which revealed striking differences among the infants. Mavilya classified the infants' utterances as either speech or non-speech using a presumably exhaustive set of definitions of non-speech, including such sounds as burps, grunts, gurgles and hiccoughs. The three hearing impaired infants engaged in progressively less speech and non-speech activity as they grew older. The normally hearing infant increased his speech activity and decreased his non-speech activity. These results suggest differences in the developmental patterns of normally hearing and hearing-impaired infants which may be evident by three months of age. Like Lenneberg's, Mavilya's results must be regarded as tentative because of her small data base. Nevertheless, her work does provide an additional example that simple observational techniques have rich possibilities for tracking the early vocal development of young infants.

A Preliminary Study Examining Large Samples of Infant Vocal Behavior. During the contract period the research group at the University of Kansas Medical Center has followed Mavilya's lead by developing new observational techniques and applying them over a wider age range. So far, we have intensively studied two infants. One infant was observed from one week to 20 weeks of age. The second was first observed at four weeks and was observed until 52 weeks of age. While this infant hears normally, both of his parents are deaf. Approximately 5 recording sessions each week have been conducted by the infants' mothers. The sessions were usually 10 minutes in length. The mothers were encouraged to make the recording a regular part of the infant's schedule and to do it at approximately the same time each day. The mothers were also asked not to interact verbally during the recording session. We have good evidence from our frequent home visits, setting information sup-

plied by the mother, and from the recordings themselves that the mothers complied with these instructions. Two observers scored the audio recordings. These observers knew neither to which infant they were listening nor the age of the infant when the recording was made. The order of listening to the tapes was non-systematic. The productions were scored three ways. First, a non-speech sound was scored any time that the infant uttered a sound of the sort described fully by Mavilya (1969). All other utterances by the infants were classed as speech. The third measure, vocalization, is the total of speech and non-speech. We calculated both the rate and the duration of each of these three measures.

A number of traditional techniques have been applied to assess reliability. Suffice it to say, for present purposes, that by traditionally reported techniques, our observers were highly reliable ($r > .93$ for all measures for each child). Correlations were calculated for the two observers' mean weekly rate scores for each of the two measures for each of the two infants. All of these correlations yielded r's greater than .93. More recently collected pilot data have yielded similar correlations based on the rate scores for individual sessions for two observers.

Figures 1, 2, and 3 describe the changes in the rate of production, respectively, of vocalization, speech, and non-speech sounds as the infants develop. The clear increase in speech activity and decrease in non-speech activity is substantiated by statistical analysis of the slopes of the functions.

Figures 4 and 5 compare the duration data collected in our laboratory with those collected by Mavilya (She did not report rate). The figures show the amount of time the infant was engaging in a speech or non-speech sound relative to the amount of time that he was engaged in any vocal activity (that is, vocalizing). Figure 4 shows the developmental trends for speech-

Figure 1. Mean weekly rate of production of vocalizations for two infants.

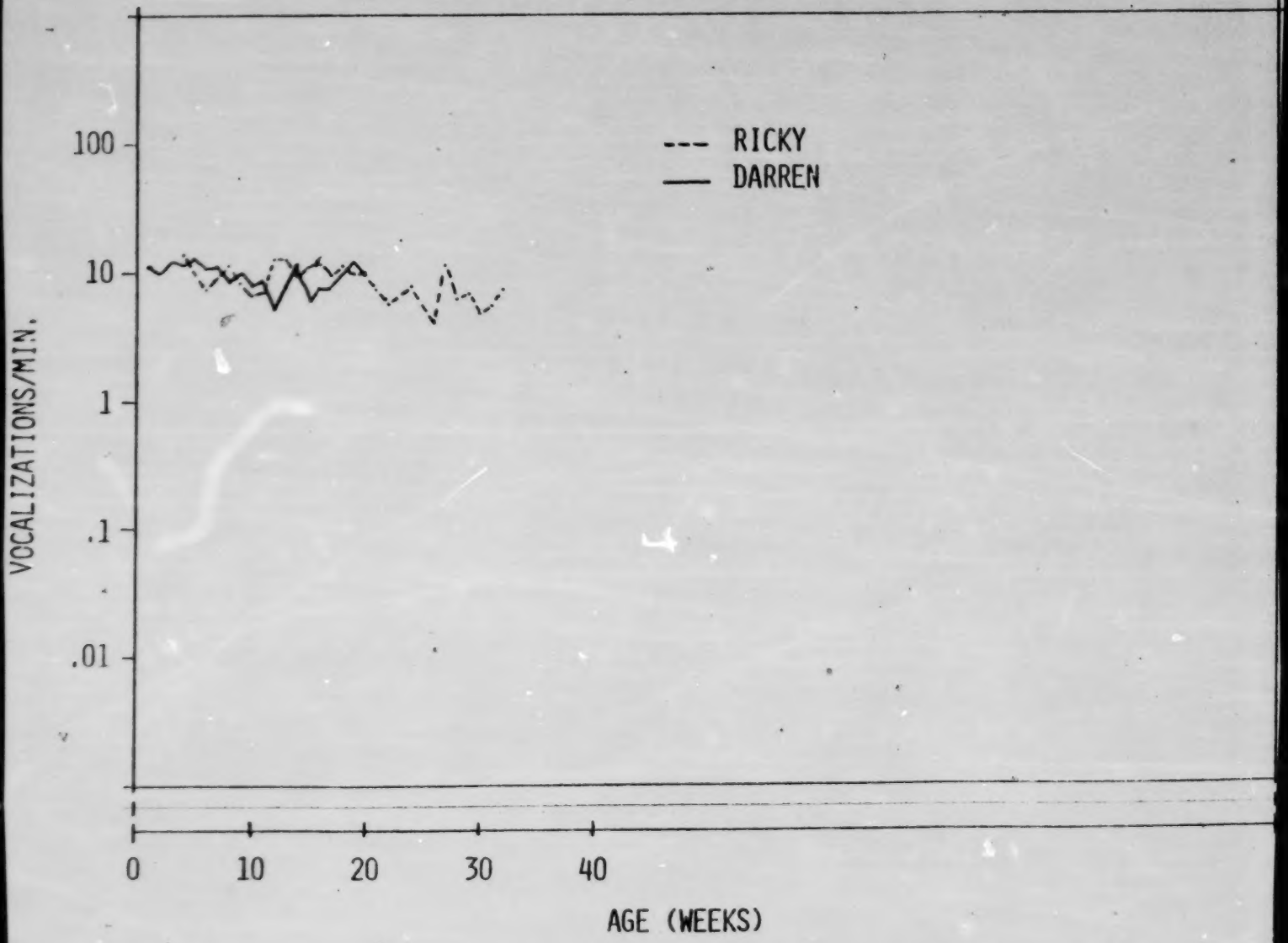

--- RICKY
— DARREN
100
10
1
.1
.01
VOCALIZATIONS/MIN.
0
10
20
30
40
AGE (WEEKS)

Figure 2. Mean weekly rate of production of speech sounds for two infants.

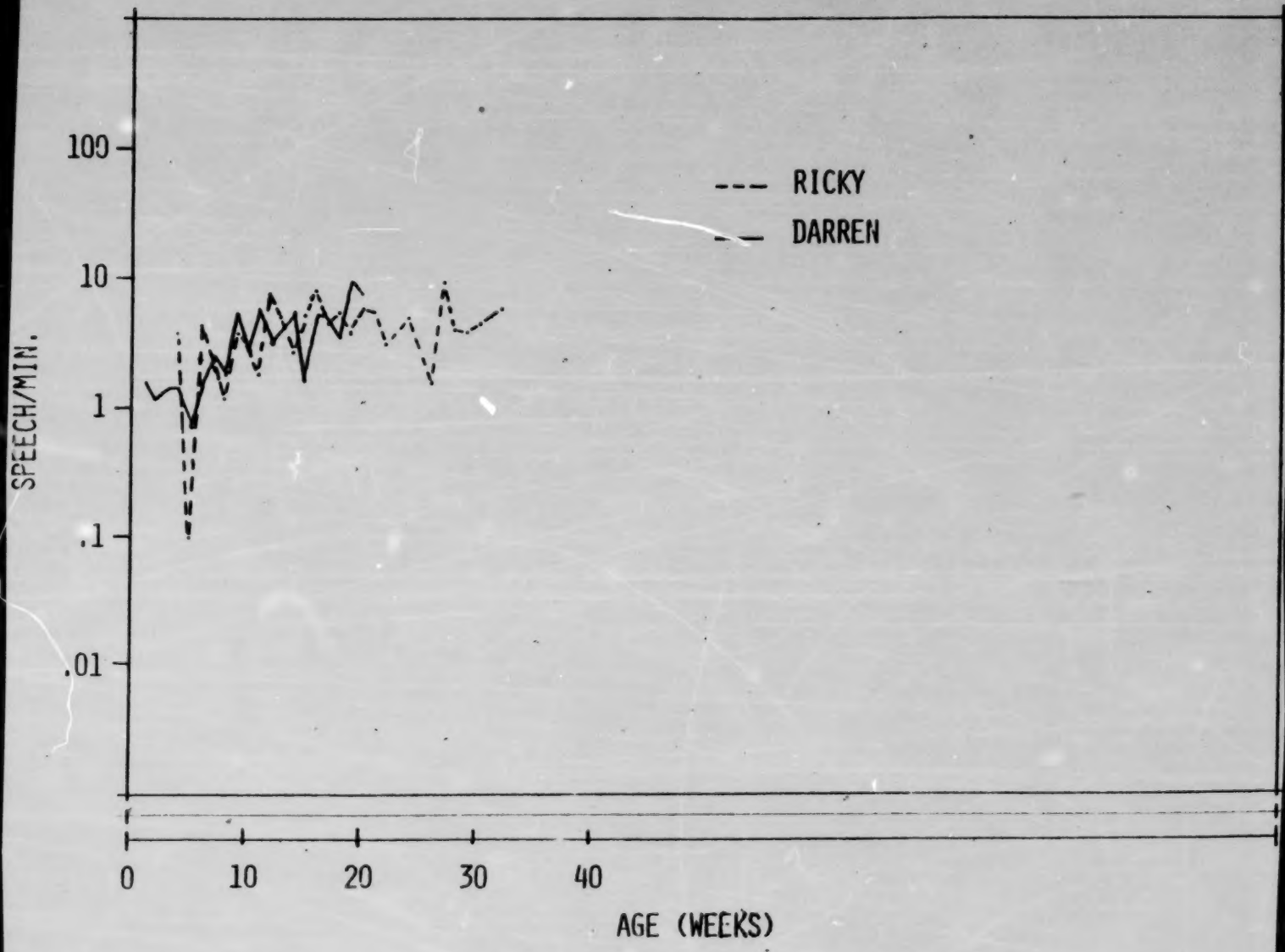

100
10
1
.1
.01
SPEECH/MIN.
--- RICKY
— DARREN
0
10
20
30
40
AGE (WEEKS)

Figure 3. Mean weekly rate of production of non-speech sounds for two infants.

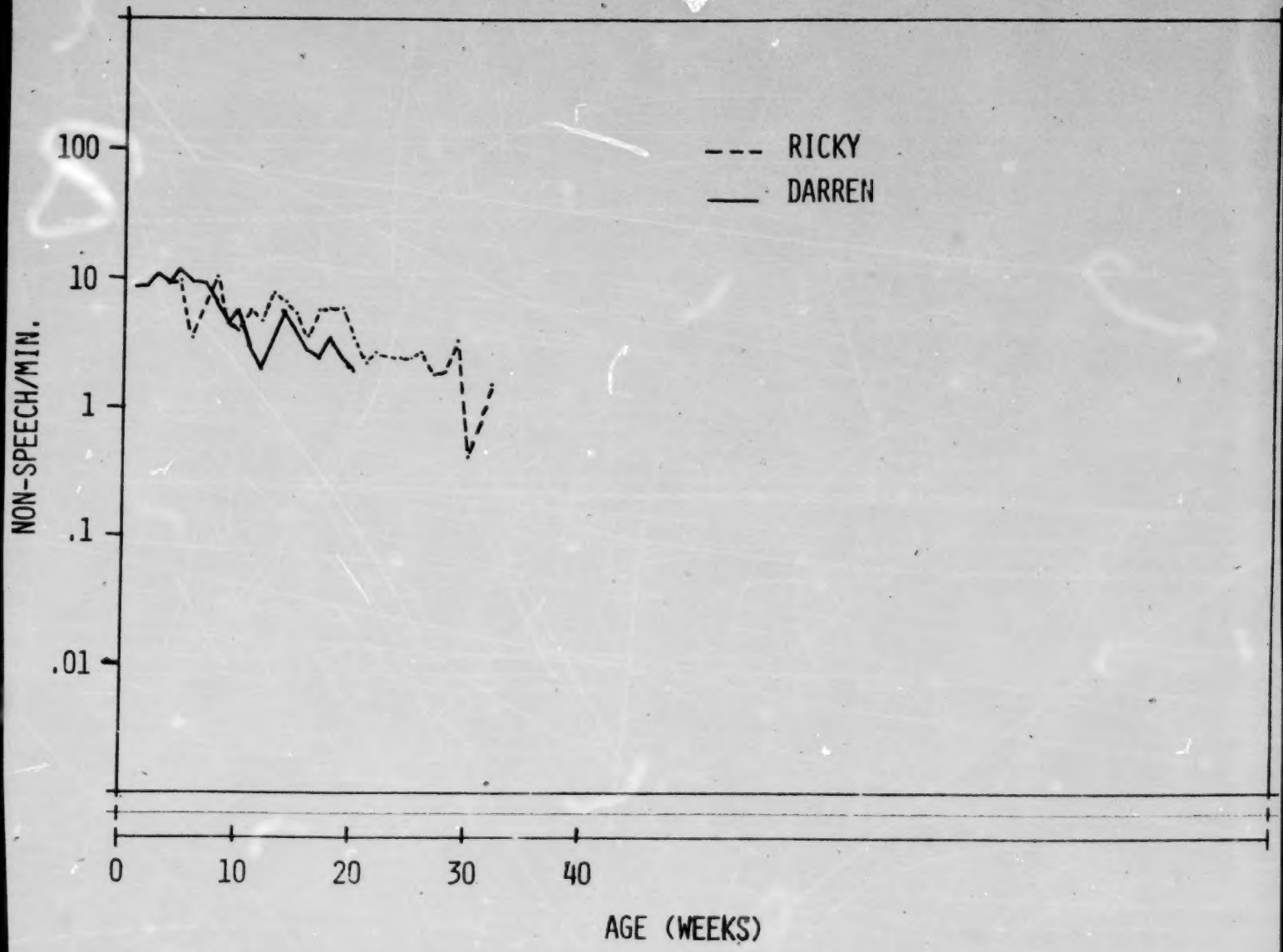

RICKY
DARREN
100
10
1
.1
.01
NON-SPEECH/MIN.
0
10
20
30
40
AGE (WEEKS)

Figure 4. Comparison of duration of speech-like activity for Mavilya's three hearing impaired infants, Mavilya's normally hearing infant and two normally hearing infants observed by Cairns & Karchmer. (Each data point plotted is the average of the raw score for that week and the two adjacent weeks.)

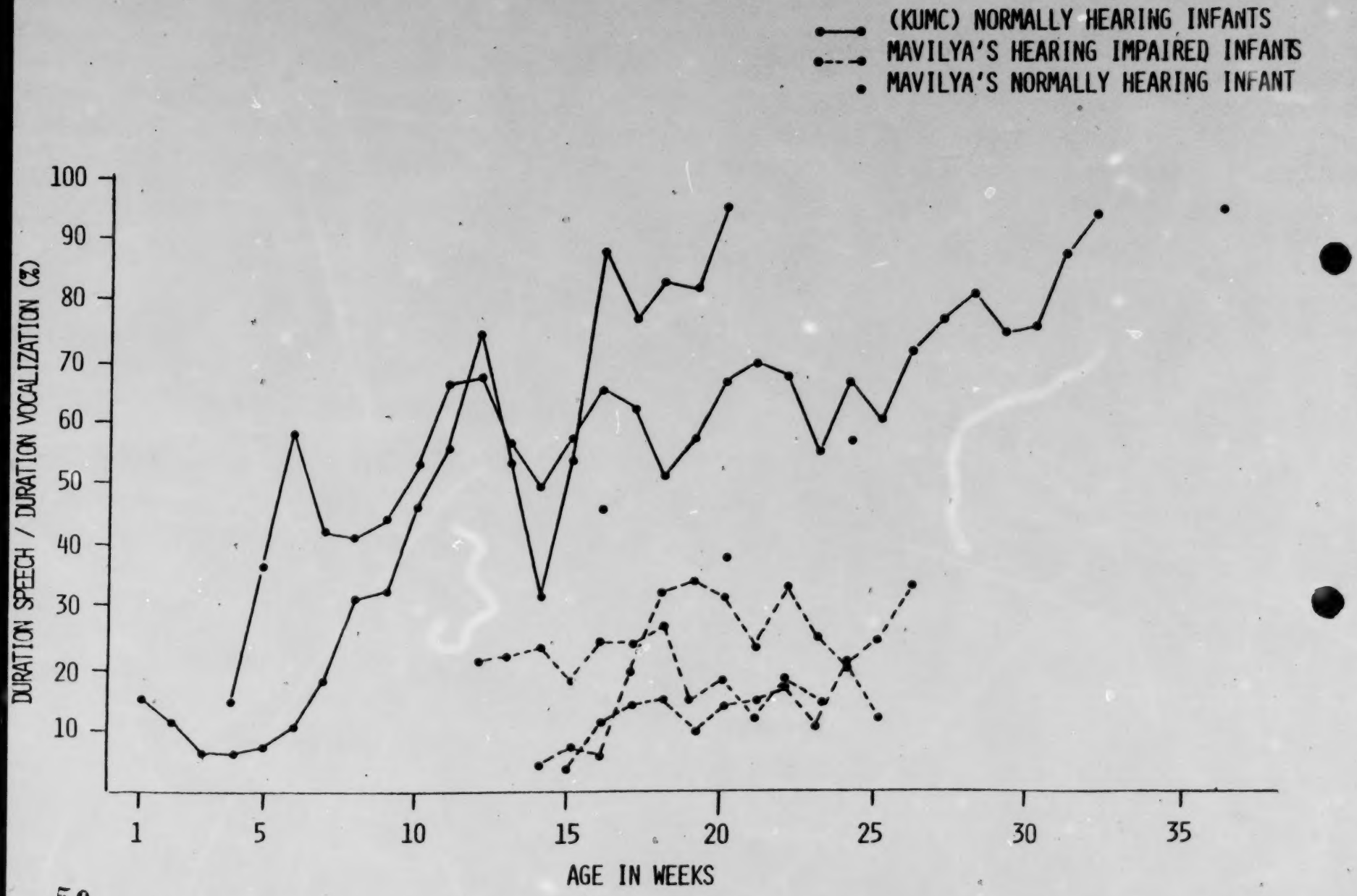
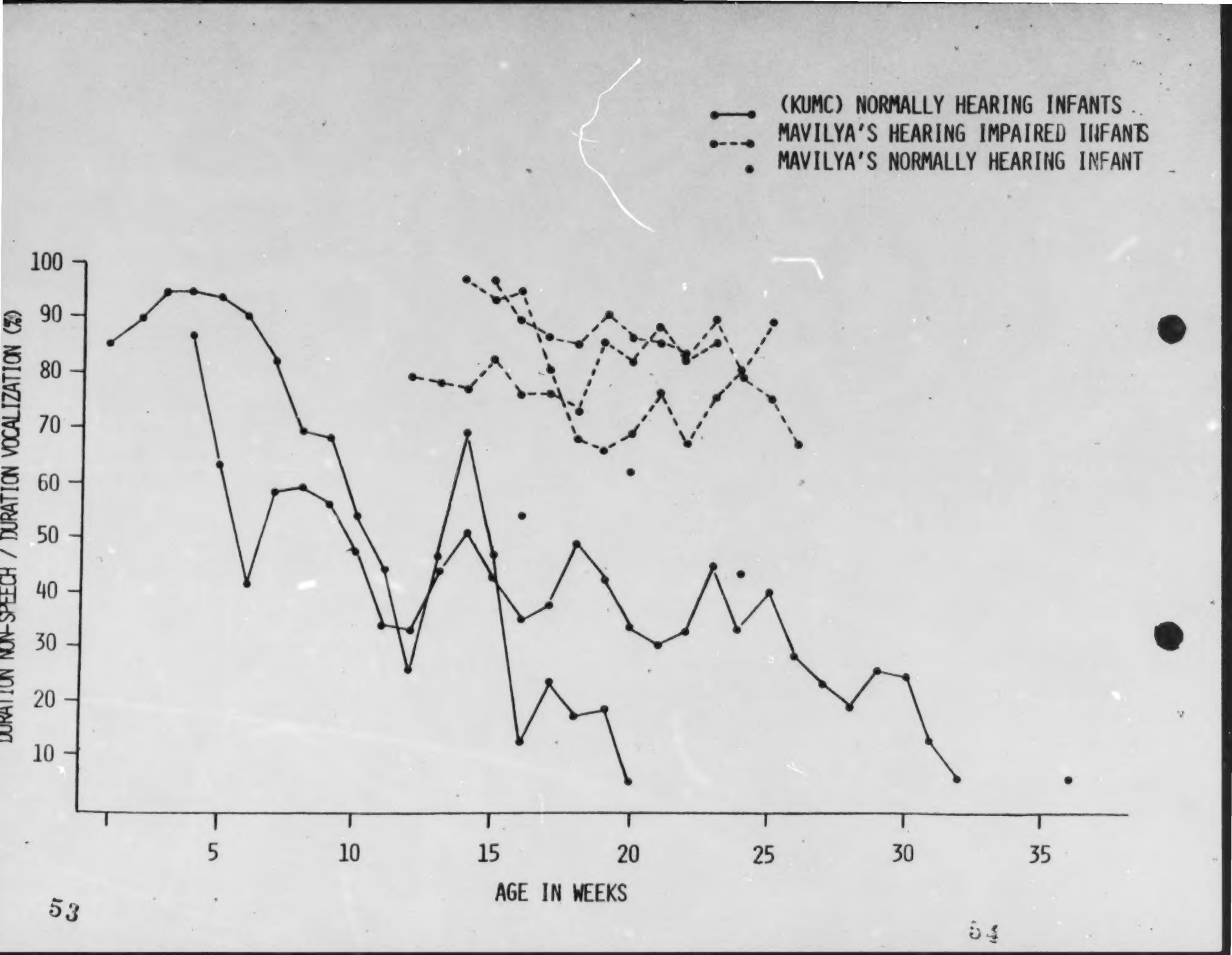

(KUMC) NORMALLY HEARING INFANTS
MAVILYA'S HEARING IMPAIRED INFANTS
MAVILYA'S NORMALLY HEARING INFANT
DURATION SPEECH / DURATION VOCALIZATION (%)
100
90
80
70
60
50
40
30
20
10
1
5
10
15
20
25
30
35
AGE IN WEEKS

Figure 5. Comparison of duration of non-speech activity for Mavilya's three hearing impaired infants, Mavilya's normally hearing infant and two normally hearing infants observed by Cairns & Karchmer. (Each data point plotted is the average of the raw score for that week and the two adjacent weeks.)


(KUMC) NORMALLY HEARING INFANTS
MAVILYA'S HEARING IMPAIRED INFANTS
MAVILYA'S NORMALLY HEARING INFANT
DURATION NON-SPEECH / DURATION VOCALIZATION (%)
100
90
80
70
60
50
40
30
20
10
5
10
15
20
25
30
35
AGE IN WEEKS

like activity. Figure 5 (the mirror image of Figure 4) indicates the developmental trends for non-speech activity. Please note that Mavilya's normally hearing infant (unconnected circles) look very similar to the two infants we observed (solid lines).

We recognize the impossibility of drawing strong conclusions from comparisons across different studies with different infants conducted by different investigators at different times. But comparisons can suggest worthy directions for future research, and this comparison strongly suggests that the hearing impaired infants are engaging in more non-speech activity and less speech activity than are the normally hearing infants. At the very least these data cry out for confirmation.

During the contract period data were collected from an additional 4 infants. One of these infants was normally hearing. It is likely that a second had varying loss due to repeated ear infections. Two additional infants whose parents were congenetially deaf were studied. One infant was normally hearing. While the second infant was found to be normally hearing at 9 months, at 12 months she was found to have a profound loss. Several reexaminations have confirmed that this infant does have a profound loss. The infant is otherwise developing in a normal manner. These data are currently being analysed.

All of the research summarized above used observers' judgements to segment and classify the infants' stream of vocal behavior. Using observers to segment and classify has allowed the examination of relatively large samples of infant vocal behavior, but it has left us with important uncertainty about what was observed. The training of observers has typically used broadly specified definitions of both the segments and their classifications. The dimensions underlying the perceptual judgements are, therefore, not clear.

A Recent Example of a Restricted Sample Technique. A second approach has

been to segment and classify a much smaller sample of utterances using both acoustic criteria and observers' judgements. The high cost of performing acoustic analyses required that the sampling be restricted. This strategy allows a relatively rigorous specification of the segmental unit and also allows a direct comparison of observers' judgements with the acoustic and phonetic features underlying these judgements. But it leaves important uncertainties about how representative the findings are of the infant's vocal behavior.

An excellent example of this approach is a study conducted by Stark, Rose and McLagen (1975). They reported data on the development of vocal behavior across the first eight weeks of life. Their method for sampling vocalizations and their system for classification is perhaps the best yet reported. Stark et al. (1975) first used a highly selective sampling procedure to extract 7 to 10 minutes of vocal behavior from 90 minutes of recordings of each infant. They then used acoustic criteria to segment the sampled vocalizations. They defined a vocalization series (their largest unit) as an utterance separated from all others by more than two inspiratory sounds. They then asked judges to sort these series into three loosely defined categories. These categories (cry sounds, discomfort sounds, and vegetative sounds) were loosely defined both as a function of the overall sound characteristics of the utterance and of the accompanying behavior of the infant. If they had stopped at this point, their study would have been similar to the large sample approach with the exceptions that they had examined a small sample of behavior and they had grossly segmented vocalizations into series using acoustic criteria. However, they then segmented the infant's utterances into progressively finer units. First, they classified the utterances into units separated from all others by at least 50 msec of silence. These vocalization segments were further subdivided into sections

bounded by intensity notches with a slope of at least 3 dB per 30th of a second, and a minimum depth of at least 3 dB. These vocalization sections were the basic units for fine-grained scoring using phonetic transcription techniques.

While Stark et al. (1975) did not find any developmental trends during the first eight weeks of life for the two infants studied, they did find several phonetic features which systematically differentiated the gross categories of cry, discomfort, and vegetative sounds. For example, they found significant differences of the relative occurrence of egression, voicing, and vowel-like features in the cry, discomfort and vegetative categories. The cry category had the highest proportion of the egression, voicing and vowel-like features; discomfort sounds ranked second in the relative occurrence of these features; and vegetative sounds ranked lowest.

Thus, this study provides evidence that there are underlying phonetic features that covary with observer's global categorization. However, this preliminary report does not demonstrate any developmental trends during the first eight weeks of life either for the global classifications or for the phonetic features. It is likely that this lack of sensitivity is, at least in part, due to the short developmental period studied and the age of the infants. The data collected by Cairns and Karchmer (1975) also do not show developmental trends until about 6 weeks of age.

Quantitative changes in infant vocal productions are also related to general developmental status. Roe (1968, 1975) tape recorded bimonthly samples of vocalizations by 28 normally developing male infants in free play settings. Fourteen of the infants were recorded from three months to nine months of age; the other 14 infants were recorded from 9 to 15 months. Roe categorized the spontaneous vocalizations of the infants as crying, whining, laughing, or neutral talking. She then measured the percent of time in each

session devoted to each type of vocal activity. She found that as the infant got older, an increasingly larger proportion of his total vocalization was neutral talking, although (due to great subject variability) the absolute amount of neutral talking did not increase significantly. The most provocative aspect of Roe's data has to do with individual differences. She reported that the percent of the time individual infants devoted to neutral talking peaked and then declined. The age of the peak was variable, with a median six months. There was a negative correlation between the age of this neutral talking peak and Overall Gesell Developmental scores at age nine months. That is, the earlier an infant peaked in his neutral talking activity, the higher he scored on the developmental scale.

In summary, data recently collected using the macroquantitative strategy indicate that vocal behavior changes systematically during early infancy. There is also a suggestion that deaf infants differ from normally hearing infants in their early productions. It is still unclear how early this divergence takes place. The work of Lenneberg et al. (1965) suggests that deaf infants vocalize similar to hearing infants until the beginning of the babbling period. Our reanalysis of the work of Mavilya (1969) suggests that production differences may be found as young as two months of age. In addition, Roe's data (1975) show that patterns of infant vocal behavior are related to general developmental status. Data collected with the macroquantitative strategy suggest that individually reliable assessment procedures may soon be developed.

F. Conclusions

Two crucial questions must be answered before effective assessment of infant's production skills is to be developed. First, do infants' productions reflect in any way the same or similar processes that will later underlie language? Secondly, if these behaviors do reflect similar processes,

can individual differences in them be detected during infancy?

Debate still rages about whether infant productions relate to later language use. Some argue that deviant vocal behavior does not even begin to emerge until six to nine months after birth. We believe that recent data question this argument. Findings by both Fry (1966) and Mavilya (1969) suggest that young deaf infants' productions are different from those of normally hearing infants. Data gathered with microquantitative strategy show that infant productions can be shaped by environmental influences, showing potential for early behavioral divergence. The work of Roe (1968, 1975) also suggests that some aspects of infant vocalization are related to subsequent development. Thus, the current literature indicates that there are early production differences, and these differences do differentiate normally developing infants from impaired ones. Infants' vocal productions are potentially useful behaviors for assessment.

The only direct test of the hypothesis that similar processes underlie vocal productions in infancy and childhood would be to examine production skills throughout infancy and early childhood, and to compare many aspects of the response topography at different developmental stages. Such an effort has not been made. The suggestion that infants' productions reflect their general language capabilities is limited by the available circumscribed data base. Systematic intensive investigations of small numbers of infants over the first few years of life will be needed if a comprehensive understanding of the processes underlying early language development is to be achieved.

The second question is even more difficult to answer. Before sensitive assessment procedures may be developed, it must be decided what kinds of assessment are desired. There are three assessment functions: (1) Screening, (2) Diagnosis, and, (3) Tracking. Each requires a different kind of assessment.

Screening is the least sophisticated assessment function. Only a binary decision is needed: the infant is either normally developing or he is impaired. Several of the approaches discussed earlier in this section of the report hold promise as effective screening instruments. Since the cost of screening must be low, use of the macroqualitative approach is probably indicated. A standardized test or some macroqualitative derivative seems most appropriate. However, increasing the sensitivity of these instruments will probably require additional knowledge about language development. Refinements of the more sophisticated kinds of tests discussed below will point the way.

Diagnostic tests must do two things. First, they must identify a handicapping condition. Secondly, they indicate a treatment. Because of the costs to the child of being labeled (Hobbs, 1975), many believe a test should not be administered unless it can do these two things. To our knowledge, there are no tests for assessing infant productions that can.

Tracking behavioral change is the most sophisticated function of assessment, and that is presently impossible. This precludes the frequent assessment of an infant's progress to determine whether intervention is working. There is an intimate relationship between tracking and understanding the basics about the development of language. Tracking will require far more than our present rudimentary understanding of the sequencing of development. Tracking requires that we know sequencing for individual infants. While tracking may be expensive, it can be combined with intervention routines which reduces its effective cost. It would also provide important detailed information about language development. Many of the procedures in the section on macroquantitative strategy could be applied to this task. But we see two kinds of problems that must be solved. One concerns sampling and the other concerns measurement sensitivity.

There are several problems of sampling. One of the most difficult is to work with a heterogeneous population within which there are appreciable individual differences. The infant assessment researcher must literally pull himself up by his bootstraps. He needs to examine defective infants to see if his assessment tool discriminates them from normally developing ones, but there is no good method for detecting the defective infant very early. One strategy that we have employed is to pick normal infants and ones who are likely to be deaf because their parents are both congentially deaf (Cairns and Karchmer, 1975). Others have looked at Down's syndrome infants (Oller, personal communication). There are problems with this approach. For example, assessing the degree of hearing loss in early infancy is extremely difficult, and some losses seem to become progressively worse during infancy. There are also difficulties studying Down's syndrome infants because of the high incidence of vocal tract anomalies in this population. There is no simple solution to this problem. Because of the cost of carefully studying an infant longitudinally, large numbers of infants cannot be sampled with the hope of finding large developmental variations. It seems likely that the only way this research can proceed is to develop procedures carefully with normally developing infants and then to carefully select a group of high risk infants to be intensively studied.

A second sampling problem concerns the amount of behavior studied and the nature of the response unit examined. For example, if acoustic analysis of an infant's productions is required by the response definition, then only a very limited sample of the infant's behavior may be economically taken. If observer's judgements are used, a much larger sample may be scored.

The crucial criterion for selection of sample size and response units is the degree of differentiation between normally developing infants from those who are impaired. Theoretical richness and ease of measurement are

also important considerations, but if the measurement system is not sensitive, then all other considerations are irrelevant.

Several levels of behavioral sampling have been tried, and they suggest that relatively short (5 to 10 minute) samples taken three times per week to once a month provide useful data. The optimal sample size and intersample interval has not been empirically established.

Several response units have been used. Mavilya (1969) and Cairns and Karchmer (1975) used a speech/non-speech dichotomy for classifying infants' utterances. Irwin and his associates (Irwin, 1947a; 1947b; 1949, Irwin & Chen, 1941; 1946) used the phoneme as their unit of analysis. A strong case can be built for the view that the syllable serves as a basic organizing principle in both the production and perception of speech. Advocates of the syllable as the basic speech processing unit (Liberman & others, 1967; Massaro, 1972; Savin & Bever, 1970; Rubin, 1974) cite evidence concerning reaction times to phoneme vs. syllable targets, and a group of studies--delayed auditory feedback, perception of switched speech, backward recognition masking—which indicates that speech is processed in syllable sized temporal units, on the order of 250 msec.

Further, it seems clear that any attempt to chunk the acoustic waveform of speech into linguistically relevant segments will likely depend on the syllable. Attempts at isolating segments corresponding to a smaller linguistic unit, have generally failed (Harris, 1953; Liberman et al., 1967; LaRiviere & Winitz, 1975). This evidence does not necessarily argue against the reality of the phoneme, but is usually taken to indicate the presence of mechano-inertial constraints and anticipatory movements in articulation. The acoustic result is a spread of features among adjacent "phonemes."

The direction and extent of such coarticulations are not completely known, but there is evidence that these smearing effects are greatest within

the syllable. Still, coarticulatory effects have been shown by several investigators (Treon, 1970; Ohman, 1966a; Ali, et al., 1971; Lewis, Daniloff & Hammarberg, 1975) to cross syllable boundaries, and have led some to the view that there are no directly observable physiological or acoustic properties distinguishing syllablic and non-syllabic segments. Recently, however, Mermelstein, (1975) reported a syllable segmentation program, utilizing amplitude information, that produced error rates below 10% in analyzing a real speech spectrogram.

Again, no direct empirical evaluation has been made of the functional efficacy of one particular response unit over another. While the syllable holds promise as a useful unit, only preliminary attempts have been made to describe it acoustically for infants (Stark et al. 1975).

In summary, we have only begun to understand the nature and importance of infant vocalizations. While some progress has been made towards developing screening instruments based on infant productions, they are still relatively insensitive, particularly in early infancy. More sophisticated practical assessment procedures need to be developed. Only preliminary information is available about the early sequencing of infant productions. Few attempts have been made to compare methodologies in an attempt to increase precision of measurement.

IV. Assessing the Perceptual and Conceptual Precursors of Language Development

Prior to 1970, few students of language development concerned themselves with nonlinguistic processes. Then, at the turn of the decade, there arose a consensus that language development could not occur without prior perceptual and conceptual development. The idea was that linguistic structures take advantage of and are built upon perceptual and cognitive structures. Little research has yet capitalized on this insight. Too little time has passed

for investigators to sort out the logic of the requisite investigations and to develop the tools needed to realize that logic. It is a shame, because the insight offers hope that the study of language-relevant processes might be pushed well below the age at which children first speak. There seems little doubt that major new empirical findings will stem from the insight, once it is more fully rooted.

The dependency of language upon cognition might free the study of language development from one of its chief anchors, which is that poorly formed or grammatically incomplete utterances are open to multiple interpretations. By virtue of its immaturity, young and developmentally delayed children's speech is full of ambiguities. The younger or more delayed the child, the less complete and the more ambiguous his utterances. The student of language development has to resolve these ambiguities in order to draw conclusions about the nature of language development. As a consequence, his most basic data have been a complex mix of observation and interpretation. Acknowledging the primacy of perceptual and cognitive processes promises to unmix his data base by suggesting an objective alternative to such heavy reliance upon productive language. That alternative is the direct measurement of cognitive and perceptual processes. The hope is that the developmental psycholinguist will be able to employ assessments of cognitive and perceptual processes as independent checks on the validity of his interpretations of children's utterances, interpretations that he must make if he is to understand the development of linguistic competence. The hope is further that the study of perception and conception will allow linguistically-relevant investigation with children who do not speak at all.

Turning these hopes into realities will require independent measures, first, of language processes and, second, of perceptual and conceptual structures upon which the language processes might be built. Substantial progress

has been made toward the measurement of language with children two years and older (See other sections of this Report). What is lacking is a variety of procedures with which to measure perceptual and conceptual processes prior to the first two years of life. Most experimental reports whose titles and discussions make them seem pertinent to the question of how to assess language-related perceptual and conceptual factors are not pertinent. The reason is that they measure linguistic processes only, and they infer non-linguistic processes. This fails to realize the promise of the focus on conception and perception. To realize that promise requires that the perceptual and conceptual factors be observed, not left to the imagination of the investigator.

There are as yet few empirical demonstrations of the utility of showing direct relationships between cognitive performance and linguistic performance. But there are instructive examples. Greenfield, Nelson, and Saltzman (1972) showed major changes between 11 and 36 months of age in the ways children nest cups that are graduated in size. Analyses of the nesting relations demonstrated by the children led the authors to conclude that the youngest children's strategy took the form of a simple sentence: subject-verb-object or, alternatively, actor-action-acted upon. The strategy of somewhat older children took the form of a compound sentence: subject-verb-object and subject-verb-object. The nesting strategy used by the oldest children took the form of a sentence containing a relative clause in which a single noun phrase served simultaneously as an object and a subject: subject-verb-(object, subject)-verb-object or, alternatively, actor-action-(acted upon, actor)-acted upon.

The critical observation in this experiment is that the developmental order of nesting strategies is the same as the developmental order of sentence production: simple sentences first, compound sentences second, and sentences

with relative clauses third. This correlation allows Greenfield et al. (1972) to attribute greater significance to the developmental sequence of spoken sentence types than they could if they lacked the independent evidence that the cognitive strategies of children follow a similar progression. More important for present purposes, Greenfield et al. have established the possibility of studying language-relevant processes among pre-linguistic populations. Many of their child subjects were well below the age of speaking. But the delay between the emergence of the nesting strategies and the emergence of spoken exemplars of the various sentence types poses difficulties. If there is a common underlying cognitive development that determines the manifest order of both nesting strategies and spoken sentences types, why should sentences manifest themselves so much later? Greenfield et al. (1972) say: "The precise developmental timing of different manifestations of the same capacity would depend upon relative amounts of experience in different domains, as well as upon the different information processing skills involved in the various manifestations of the single structure (p. 308)." By this view, one must not only analyze language and cognition, one must identify the variables that determine when cognitive capacities are expressed in language. Until that identification is made and the roles of each variable are spelled out in detail, there will remain uncertainty as to whether nesting skills do reflect cognitive structures upon which sentences are later built. This problem of large age gap between observed cognition and observed language use has been avoided by some Piagetian researchers.

Piaget has made much of the cognitive significance of the development of different sorts of imitation. The earliest kind of imitation with which he credits the infant has this form: infant does A; adult imitates A as a model for infant; infant does A again. This is called pseudo imitation, and it occurs during the first 3 or 4 months of life. The next development is

imitation of gestures which the infant can see himself perform. Piaget credits the infant with imitation of visible gestures when he does something that he has not recently done with a visible portion of his body shortly after a model performs that act. Infants do this from three to five months on. Imitation of acts that the infant cannot see himself perform comes later. It refers to the infant doing something with an invisible portion of his body (e.g., his face) shortly after seeing a model do that thing. Finally, there is deferred imitation, which typically occurs at 18 months or later. Instead of imitating only while the model is present, the infant sometimes imitates after the model's departure.

According to Piaget, the occurrence of deferred imitation signals the development of the ability to act upon representations of events. That ability, in turn, is required for the development of productive language. Accordingly, children should not speak until they make deferred imitations. Kahn (1975) provided a particularly strong test of this prediction by studying profoundly retarded people, who begin to speak much later than normal children.

Kahn (1975) used naturalistic observations to identify 8 profoundly retarded people who spoke 10 or more words, and 8 who did not speak at all. Those with spoken language averaged 71 months of age, and those without averaged 67 months, a trivial difference. He administered a standardized scale (Uzgiris & Hunt, 1966) to assess whether the children had achieved Piaget's Stage VI of sensorimotor development. One of the subtests of the Uzgiris and Hunt scale measures imitation, and for our purposes we need focus only on it.

Kahn found that none of the 8 nonspeaking retarded people passed the test for deferred imitation, but 7 of the 8 speaking ones did pass. This finding is compelling support for Piaget's analysis, since it shows that

deferred imitation is an imposingly accurate predictor of language use even among a group with marked language delays. By studying severely retarded people, Kahn importantly reduced the chances that unknown age-related processes mediate the correlation between deferred imitation and speaking, thereby greatly strengthening Piaget's theoretical analysis. According to Piaget's analysis, the age at which cognitive accomplishments occur is unimportant--the important thing is their sequencing. Kahn's data show that the sequence of deferred imiation followed by speaking is invariant across widely varying ages. His findings also suggest that it may be useful to determine where retarded people fall in relation to Piaget's cognitive stages before undertaking to teach language to them. Methodologically, Kahn's results established the feasability of attending simultaneously and independently to cognitive and language behaviors. Bates, Camaioni and Volterra (1975) have importantly generalized this multi-process approach to include social as well as cognitive and linguistic factors.

Bates et al. (1975) argue that prelinguistic behavior presages language, and to test this hypothesis they are seeking cognitive and social behaviors whose forms resemble subsequent language forms. The idea is that language forms have a performance base before they are internalized as linguistic rules. Accordingly, they have undertaken longitudinal observations of cognitive, social and language performances, seeking formal similarities across the three domains. The observations that they have so far reported are only preliminary, but they are very encouraging. Unlike most investigators of language development, Bates et al. have informed their work with nonlinguistic theory. Thus, they are making astute use of Piagetian theory and Spitz's notions of early social development. In our judgement, viewing the child from social and cognitive, as well as linguistic perspectives promises the sort of developments that are required for helpful assessment procedures.

So far, however, Bates et al. have relied on observational procedures that require so much time and so much sophistication that they cannot be applied productively to assessment problems in clinical settings.

Perhaps the only immediately applicable assessment procedure that is being used to study the cognitive and perceptual underpinnings of language is the Piagetian scale developed by Uzgiris and Hunt (1975). Its manual documents the administration of the scale in sufficient detail for it to be administered by subprofessional employees. While its standardization is not nearly so adequate as that of individual intelligence tests like the Stanford-Binet, it fits much better into a theoretical scheme that should allow useful interpretations. Moreover, there are signs that it will be used extensively in research that is concerned with language development, so that its practical utility for identifying young children with prospects of poor language development should be known before long. Aside from this instrument, the time has yet to come when useful assessment procedures will be available for evaluating linguistically-relevant cognitive and perceptual factors.

V. Recommendations

Our analyses of the literatures that speak of receptive language, of productive language and of relevant perceptual and cognitive factors among pre-linguistic infants lead us to two sets of recommendations. The first set, called Methodological, are content free. They are designed to make whatever research is supported by the Bureau of Education for the Handicapped immediately translable into practical benefits for disabled children. The second set of recommendations, called Substantive, are our best estimates of the sorts of research that will maximize the likelihood of promoting language development among developmentally disabled children.

A. Methodological Recommendations

We were dismayed to discover how much of the research we reviewed fell short of the minimal requirements that experimental work must meet in order to be translated into practical assessment and intervention routines. The short-comings were not subtle. Few experimental investigations employed procedures that could yield meaningful results from individual children. Few experimental reports reported reliability estimates of their procedures, regardless of whether they were designed to yield meaningful information about individual infants. No investigator was concerned with the cost effectiveness of his procedures. These problems should not be perpetuated by the Bureau of Education for the Handicapped. Rather, we recommend that the Bureau:

1. Support only research whose procedures yield data that would support clinical decisions about individual infants;
2. Require reliability estimates for all procedures used in the research it supports;
3. Require evidence about the durability of individual differences in performance;
4. Require efforts to manipulate performance in order to determine whether the subject matters of supported research provide reasonable targets for intervention programs, and
5. Require cost effectiveness estimates that take into account per-child expenses and national incidence figures.

B. Substantive Recommendations

We believe that the three substantive areas of investigation that we have reviewed are all relevant to the goal of implementing and assessing effective language intervention programs, but the three fields are differentially developed. Payoffs will come more quickly in some than in others.

Thus, the time required to develop individually-reliable measures of hearing sensitivity would be very short if modest funding were made available in the form of contractual moneys. The principles are all known and only technological refinement is required. The development of good procedures for assessing speech perception are necessarily further away, since the basic understanding of perceptual mechanisms even among adults is far from complete. Moreover, there are no demonstrations that speech perception mechanisms differentiate developmentally delayed from normal children nor that perceptual capability predicts subsequent differences in language use. Least of all is known about general cognitive and perceptual factors that might underlie subsequent language development. The most promising approach in this area concerns the possibility that Piagetian scales of cognitive development may provide important information about subsequent language development and about who is ready to benefit from language training.

We are ignorant of the realities of the Bureau's research funding capabilities. If funds were unlimited, we would recommend the funding of a few, broad-ranging programs that studied receptive, productive and relevant cognitive factors simultaneously. But even unlimited funds might not permit this strategy to succeed, since few research settings could provide the range of expertise required. Moreover, the talents required would be extraordinary, and exceptionally-talented researchers may not yet be prepared to accept the discipline required of such mission-oriented research. Scientists still consider themselves more as individuals than as teams, and the broad-ranging strategy would require a team effort above all. Accordingly, we recommend support of more narrowly-circumscribed efforts in each of the three areas we have reviewed.

1. Receptive Language Processes

Following the model elaborated by Wilson (1976) and Lloyd (1976),

technological research should be conducted to permit individually-reliable assessment of hearing sensitivity. The techniques developed for this purpose should be readily adaptable to the assessment of speech perception, which would permit the determination of whether exceptional populations differ with respect to speech perception early in life. Determining whether they do should also be given a high priority.

2. Productive Language Processes

The groundwork has been laid by Irwin (1947a; 1947b, 1949) for a concerted effort to develop clinically-useful techniques of assessing pre-linguistic vocal behavior. To do that, we recommend that:

1. Rather than focusing on large numbers of infants and using standard psychometric methodology, a few normally developing infants should be studied longitudinally to carefully describe the sequence of vocal development.
2. This study should begin a few weeks after birth and extend past the age of talking so that a direct examination may be made of the relationship between early productions and later linguistic behavior.
3. A multi-level evaluation of production should be conducted so that direct comparisons among levels of analysis can be made. Measures of predictability and sensitivity should be compared.
4. Standardized scales of general development should be administered in order to examine the relationships between vocal behavior and general development.
5. Clear empirical criteria should be used to evaluate the sensitivity of the various testing strategies.
6. After the preliminary study is completed, infants who are likely to be at risk for language delay should be tested in the same fashion, and compared to the normally developing infants.

3. Cognitive Underpinnings

The questions are whether the Piagetian cognitive scales differentiate delayed and normal children, and whether they strongly predict language development. Answering them requires testing Piagetian cognition and observing language development longitudinally in normal and disabled populations of children.

References

Ali, L., Gallagher, T., Goldstein, J., & Daniloff, R. Perception of coarticulated nasality. Journal of the Acoustical Society of America, 1971, 49, 538-540.

Barrett-Goldfarb, M. S., & Whitehurst, G. J. Infant vocalizations as a function of parental voice selection. Developmental Psychology, 1973, 8 273-276.

Bates, E., Camaioni, L., & Volterra, V. The acquisition of performatives prior to speech. Merrill-Palmer Quarterly, 1975, 21, 205-226.

Bayley, N. Manual for the Bayley scales of infant development. New York: The Psychological Corporation, 1969.

Belmore, N. G., Kewley-Port, D., Mobley, R. L., & Goodman, V. E. The development of auditory feedback monitoring: Delayed auditory feedback studies on the vocalizations of children aged six months to 19 months. Journal of Speech and Hearing Research, 1973, 16, 709-720.

Bench, J. Some effects of audio frequency stimulation on the crying baby. Journal of Audiolcgical Research, 1969, 9, 122-128.

Berry, M. F., & Eisenson, J. Normal development of speech. In Speech disorders: Principles and practices of therapy. New York: Appleton-Century-Crofts, 1956.

Bever, T. G. Pre-linguistic behavior. Unpublished honors thesis, Department of Linguistics, Harvard University, 1961.

Birns, B., Blank, M., Bridger, W. H., & Escalona, S. K. Behavioral inhibition in neonates produced by auditory stimuli. Child Development, 1965, 36, 639-645.

Blair, F. X. Language Evaluation Scale. Unpublished manuscript available from Department of Special Education, The University of Wisconsin, Milwaukee, undated.

Bloom, K. Social elicitation of infant vocal behavior. Journal of Experimental Child Psychology, 1975, 20, 51-58.

Bloom, K., & Esposito, A. Social conditioning and its proper control procedures. Journal of Experimental Child Psychology, 1975, 19, 209-222.

Bloom, L. Language development: Form and function in emerging grammars. Cambridge: M.I.T. Press, 1970.

Bloom, L. Talking, understanding and thinking. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974, in press.

Boone, D. R. Infant speech and language development. Volta Review, 1965, 62, 414-419.

Bowerman, M. Early syntactic development: A cross-linguistic study with special references to Finnish. Cambridge, England: Cambridge University Press, 1973.

Bricker, W., & Bricker, D. Early language intervention. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Brown, R. Words and things. Glencoe, Illinois: The Free Press, 1958.

Brown, R. A first language: The early stages. Cambridge: Harvard University Press, 1973.

Butterfield, E. C., & Cairns, G. F. The infant's auditory environment. In T. J. Tjossem (Ed.), Intervention strategies for high risk infants and young children. In press, 1976.

Butterfield, E. C., & Siperstein, G. N. Influence of contingent auditory stimulation upon non-nutritional suckle. In J. Bosma (Ed.), Oral sensation and perception: The mouth of the infant. Springfield, Illinois: C. C. Thomas, 1972.

Bzoch, K. R., & League, R. Assessing language skills in infancy. Gainsville, Florida: The Tree of Life Press, 1971.

Cairns, G. F., & Butterfield, E. C. Assessing infants' auditory functioning. In B. Z. Friedlander, G. M. Sterritt, & G. Kirk (Eds.), Exceptional infant, (Vol. 3). New York: Brunner/Mazel, Inc., 1975.

Cairns, G. F., & Karchmer, M. A. Assessment of infants at-risk for language dysfunction through the use of their speech productions. Paper presented at the meeting of the Council for Exceptional Children, Los Angeles, April, 1975.

Cattell, P. The measurement of intelligence of infants and young children. New York: The Psychological Corporation, 1940.

Chomsky, N. A. A review of B. F. Skinner's Verbal Behavior. Language, 1959, 35, 26-58.

Clark, E. V. What's in a word? On the child's acquisition of semantics in his first language. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Clark, H. H. Space, time, semantics, and the child. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Cole, R. A., & Scott, B. Toward a theory of speech perception. Psychological Review, 1974, 81, 348-374.

Collen, J. K., Fargo, N., Chase, R. A., & Baker, P. The development of auditory feedback monitoring: I. Delayed auditory feedback studies on infant cry. Journal of Speech and Hearing Research, 1968, 11, 85-93.

Condon, W. S., & Sander, L. W. Synchrony demonstrated between movements of the neonate and adult speech. Child Development, 1974, 45, 456-462.

Crystal, D. Linguistic mythology and the first year of life. An edited version of the sixth Jansson Memorial Lecture. British Journal of Disorders of Communications, 1973, 8(1), 29-36.

D'Asaro, M. J., & John, U. A rating scale for evaluation of receptive, expressive, and phonetic language development in the young child. Cerebral Palsey Review, 1961, 22, 17-19.

Dodd, B. J. Effects of social and vocal stimulation on infant babbling. Developmental Psychology, 1972, 7, 80-83.

Eilers, R. E., & Minifie, F. D. Fricative discrimination in early infancy. Journal of Speech and Hearing Research, 1975, 18, 158-167.

Eimas, P. D. Auditory and linguistic processing of articulation by infants. Perception and Psychophysics, 1974, 16, 513-521.

Eimas, P. D. Auditory and phonetic coding of the cues for speech: Discrimination of the (r-l) distinction by young infants. Perception and Psychophysics, 1975, 18, 341-347.

Eimas, P. D., Siqueland, E. R., Jusczyk, P., & Vigorito, J. Speech perception in infants. Science, 1971, 171, 303-306.

Eisenson, J., Jeffery, J. J., & Irwin, J. V. The development of speech in the child: First sounds to first words. The psychology of communication, New York: Appleton-Century-Crofts, 1963.

Ervin-Tripp, S. M. Language development. In L. W. Hoffman, & M. L. Hoffman (Eds.), Review of child development. New York: Russell Sage Foundation, 1966.

Fischer-Jorgenson, E. Perceptual studies of Danish stop consonants. Copenhagan, Denmark: University of Copenhagen, Institute of Phonetics, Annual Report VI, 1972.

Fodor, J. A., Garrett, M. F., & Brill, S. L. The perception of speech sounds by pre-linguistic infants. Perception and Psychophysics, 1975, 18, 74-78.

Fokes, J. Developmental scale of language acquisition. In B. Stevens (Ed.), Training the developmentally young. New York: John Day Co., 1971.

Fouts, G. T. Elimination of an infant's crying through response prevention. Perception and Motor Skills, 1974, 38, 225-226.

Friedlander, B. Z. The effect of speaker identity, voice, inflection, vocabulary, and message redundancy on infants' selection of vocal reinforcement. Journal of Experimental Child Psychology, 1968, 6, 443-459.

Friedlander, B. Z. Receptive language development in infancy: Issues and problems. Merrill-Palmer Quarterly, 1970, 16, 7-51.

Fry, D. B. The development of the phonological system in the normal and the deaf child. In F. Smith and G. Miller (Eds.), The genesis of language. Cambridge, Massachusetts: M. I. T. Press, 1966.

Fulton, R. T. (Ed.), Auditory stimulus-response control. Baltimore: University Park Press, 1974.

Greenfield, P., Nelson, K., & Saltzman, E. The development of rule-bound strategies for manipulating seriated cups: A parallel between action and grammar. Cognitive Psychology, 1972, 3, 291-310.

Gross, P., & Cohen, M. Developmental pinpoints. Unpublished manuscript, Experimental Education Unit, Seattle: University of Washington, 1975.

Harris, C. M. A study of the building blocks in speech. Journal of Acoustical Society of America, 1953, 25, 962-969.

Haugan, G. M., & McIntire, R. W. Comparisons of vocal imitation, tactile stimulation, and food as reinforcers for infant vocalizations. Developmental Psychology, 1972, 6, 201-209.

Hecox, K., & Galambos, R. Brain stem auditory evoked responses in human infants and adults. Archives of Otolaryngology, 1974, 99, 30-33.

Hively, W. Domain-referenced testing: Part one. Educational Technology, 1974, 14, 5-10.

Hobbs, N. The futures of children. San Francisco: Jossey-Bass Publishers, 1975.

Irwin, O. C. Infant speech: Consonant sounds according to manner of articulation. Journal of Speech Disorders, 1947, 12, 402-404.

Irwin, O. C. Infant speech: Consonantal sounds according to place of articulation. Journal of Speech Disorders, 1947, 12, 397-401. (b)

Irwin, O. C. The meaningless cries of babies fall into some remarkably meaningful patterns, the study of which shows differences among girls and boys and children of various environments. Scientific American, 1949, 181, 22-24.

Irwin, O. C., & Chen, H. P. A reliability study of speech sounds observed in the crying of newborn infants. Child Development, 1941, 12, 351-368.

Irwin, O. C., & Chen, H. P. Development of speech during infancy: Curve of phonemic types. Journal of Experimental Psychology, 1946, 36, 431-436.

Jakobson, R. Child language, aphasia and phonological universals. The Hague: Mouton, 1968.

Jenson, P. J., Williams, W. N., & Bzoch, K. R. Preference of young infants for speech versus non-speech stimuli. Paper presented at the Annual Meeting of the American Speech and Hearing Association, Las Vegas, Nevada, November, 1975.

Jerger, J. Handbook of clinical impedance audiometry. Dobbs Ferry, New York: Morgan Press, 1975.

Jones, S. J., & Moss, H. A. Age, state and maternal behavior associated with infant vocalizations. Child Development, 1971, 42, 1039-1051.

Kahn, J. V. Relationship of Piaget's sensorimotor period to language acquisition of profoundly retarded children. American Journal of Mental Deficiency, 1975, 79, 640-643.

Keith, R. W. Impedance audiometry with neonates. Archives of Otolaryngology, 1973, 97, 465-467.

Keith, R. W. Middle ear function in neonates. Archives of Otolaryngology, 1975, 101, 376-380.

Kuhl, P. K. Perceptual predispositions for the acquisition of speech-sound categories: A comparison of human infants and animals. Seattle, Washington: Conference on Early Behavioral Assessment of the Communicative and Cognitive Abilities of the Developmentally Disabled, May, 1976.

Kuhl, P. K., & Miller, J. D. Speech perception in early infancy: Discrimination of speech-sound categories. Journal of the Acoustical Society of America, 1975, 58, 556.

LaRiviere, C., & Winitz, H. The syllable as perceptual unit? Paper presented at the meeting of the American Speech and Hearing Association, Washington, D. C., October, 1975.

Lasky, R. E., Syrdal-Lasky, A., & Klein, R. E. VOT discrimination by four-to-six-and-a-half month old infants from Spanish environments. Journal of Experimental Child Psychology, 1975, 20, 215-225.

Leavitt, L. A., & Morse, P. A. Research Status Report. Madison, Wisconsin: University of Wisconsin, Infant Development Laboratory, 1975, 1-361.

Lenneberg, E. H. Speech as a motor skill with special reference to non-aphasic disorders. Monographs of the Society for Research in Child Development, 1964, 29, No. 92, 115-127.

Lenneberg, E. H. Biological Foundations of Language. New York: John Wiley & Sons, 1967.

Lenneberg, E. H. Of language, knowledge, apes, and brains. Journal of Psycholinguistic Research, 1971, 1, 1-29.

Lenneberg, E. H., Rebelsky, F. C., & Nichols, I. A. The vocalizations of infants born to deaf and to hearing parents. Human Development, 1965, 8, 23-37.

Lewis, J., Daniloff, R., & Hammarberg, R. Apical coarticulation at juncture boundaries. Journal of Phonetics, 1975, 3, 1-7.

Liberman, A. M., Cooper, F. S., Shankweiler, D., & Studdert-Kennedy, M. Perception of the speech code. Psychological Review, 1967, 74, 431-461.

Lloyd, L. L. The assessment of auditory abilities. Paper presented at the Fourth International Congress of the International Association for the Scientific Study of Mental Deficiency, Washington, D. C., August, 1976.

MacNamara, J. Cognitive basis of language learning in infants. Psychological Review, 1972, 79, 1-13.

McNeil, P. The development of language. In P. H. Mussen (Ed.), Carmichael's Manual of Child Psychology. New York: John Wiley & Sons, 1970.

Margolis, R. H., & Popelka, G. R. Static and dynamic acoustic impedance measurements in infant ears. Journal of Speech and Hearing Research, 1975, 18, 435-455.

Massaro, D. W. Perceptual images, processing time and perceptual units in auditory perception. Psychological Review, 1972, 79, 124-145.

Mavilya, M. P. Spontaneous vocalization and babbling in hearing impaired infants. Unpublished doctoral dissertation, Columbia University, 1969.

Mavilya, M. P. Spontaneous vocalization and babbling in hearing impaired infants. In C. Fant (Ed.), International symposium on speech communication, ability, and profound deafness. Washington, D. C.: Alexander Graham Bell Association for the Deaf, 1972.

Menyuk, P. Speech pathology: Some principles underlying theraputic practices. Paper presented at American Speech & Hearing Association Convention, 1968.

Mermelstein, P. Automatic segmentation of speech into syllabic units. Journal of the Acoustic Society of America, 1975, 58, 880-883.

Moffitt, A. R. Consonant cue perception by twenty- to twenty-four-week-old infants. Child Development, 1971, 42, 717-731.

Morse, P. A. The discrimination of speech and nonspeech stimuli in early infancy. Journal of Experimental Child Psychology, 1972, 14, 477-492.

Morse, P. A. Infant speech perception: A preliminary model and review of literature. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspective--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Mowrer, O. H. Speech development in the young child: 1. The autism theory of speech development and some clinical applications. Journal of Speech and Hearing Disorders, 1952, 17, 263-268.

Myklebust, H. R. Babbling and echolalia in language theory. Journal of Speech and Hearing Disorders, 1957, 22, 356-360.

Ohman, S. E. G. Coarticulation in VCV utterances: Spectographic measurements. Journal of the Acoustical Society of America, 1966, 39, 151-168.

Pennypacker, H. S., Koenig, C. H., & Lindsley, O. R. Handbook of the Standard Behavior Chart. Kansas City, Kansas: Precision Media, 1972.

Premack, D., & Premack, A. J. Teaching visual language to apes and language-deficient persons. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives—acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Ramey, C. T., & Ourth, L. Delayed reinforcement and vocalization rates of infants. Child Development, 1971, 42, 291-297.

Ramey, C. T., Collier, A. M., Sparling, J. J., Loda, F. A., Campbell, F. A., & Ingram, D. L. The Carolina Abecedarian Project: A longitudinal and multidisciplinary approach to the prevention of developmental retardation. Paper presented at PCMR ACEI National Conference on Early Intervention with High Risk Infants and Young Children, Chapel Hill, North Carolina, May, 1974.

Rheingold, H. L., Gewirtz, J. L., & Ross, H. W. Social conditioning of vocalizations in the infant. Journal of Comparative and Physiological Psychology, 1959, 52, 68-73.

Roe, K. V. A longitudinal study of infant vocalizations. Unpublished doctoral dissertation, University of California, Los Angeles, 1968.

Roe, K. V. Amount of infant vocalization as a function of age: Some cognitive implications. Child Development, 1975, 46, 936-941.

Routh, D. K. Conditioning of vocal response differentiation in infants. Developmental Psychology, 1969, 1, 219-226.

Rubin, D. C. The subjective estimation of relative syllable frequency. Perception and Psychophysics, 1974, 16, 193-196.

Sander, E. K. How significant is a baby's babbling? Elementary English, 1969, 15, 80-84.

Savin, H. B., & Bever, T. G. The non-perceptual reality of the phoneme. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 295-302.

Schlesinger, I. M. Production of utterances and language acquisition. In D. I. Slobin (Ed.), The ontogensis of language. New York: Academic Press, 1971.

Schlesinger, I. M. Relational concepts underlying language. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Sheppard, W. C. Operant control of infant vocal and motor behavior. Journal of Experimental Child Psychology, 1969, 7, 36-51.

Shultz, T. R., & Zigler, E. Emotional concomitants of visual mastery in in infants: The effects of stimulus movements on smiling and vocalizing. Journal of Experimental Child Psychology, 1970, 10, 390-402.

Siegal, G. M. Vocal conditioning in infants. Journal of Speech and Hearing Disorders, 1969, 34, 3-19.

Simner, M. J. Newborn's response to the cry of another infant. Developmental Psychology, 1971, 5, 136-150.

Sinclair-deZwart, H. Sensori-motor action patterns as a condition for the acquicition of syntax. In R. Huxley and E. Ingram (Eds.), Language acquisition: Models and methods. New York: Academic Press, 1971.

Sinclair-deZwart, H. Some remarks on the Cenevan point of view on learning with special reference to language. In L. L. Hinde and H. C. Hinde (Eds.), Constraints on learning. New York: Academic Press, 1973.

Skinner, B. F. Verbal Behavior. New York: Appleton-Century-Crofts, Inc., 1957.

Slobin, D. I. Cognitive prerequisites for the development of grammar. In C. A. Ferguson and D. I. Slobin (Eds.), Studies of child language development. New York: Holt, Rinehart and Winston, 1973.

Staats, A. W. Linguistic-mentalistic theory versus an explanatory S-R learning theory of language development. In D. I. Slobin (Ed.), The ontogenesis of grammar. New York: Academic Press, 1971.

Stark, R. E., Rose, S. N., & McLagen, M. Features of infant sounds: The first eight weeks of life. Journal of Child Language, 1975, 2, 205-222.

Streeter, L. Language perception of 2-month-old infants shows effects of both innate mechanisms and experience. Nature, 1976, 259, 39-41.

Sweeney, S. The importance of imitation in the early stages of speech acquisition. A case report. Journal of Speech and Hearing Disorders, 1973, 38, 490-494.

Telford, C. W., & Sawrey, T. M. The exceptional individual: Psychological and Educational Aspects. Englewood, Cliffs, New Jersey: Prentice Hall, 1967.

Tischler, H. Schreien, lallen und erstes sprechen in der entwicklung des sauglings. Zeitschrift Fur Psychologie Mit Zeitschrift Fuer Angewandte Psychologie, 1957, 160, 210-263.

Todd, G. A., & Palmer, B. Social reinforcement of infant babbling. Child Development, 1968, 39, 592-596.

Tomlinson-Keasey, C. Conditioning of infant vocalizations in the home environment. Journal of Genetic Psychology, 1972, 120, 75-82.

Trehub, S. E. Auditory-linguistic sensitivity in infants. Unpublished doctoral dissertation, McGill University, 1973..(a)

Trehub, S. E. Infants' sensitivity to vowel and tonal contrasts. Developmental Psychology, 1973(b), 9, 91-96.

Treon, M. A. Fricative and plosive perception-identification as a function of phonetic context in CVCVC utterance. Language and Speech, 1970, 13, 54-64.

Turnure, C. Response to voice of mother and stranger by babies in the first year. Developmental Psychology, 1971, 4, 182-190.

Uzgiris, J. C., & Hunt, J. McV. Assessment in infancy: Ordinal scales of psychological development. Chicago: University of Illinois Press, 1975.

Webster, R. L. Selective suppression of infants' vocal responses by classes of phonemic stimulation. Developmental Psychology, 1969, 1, 410-414.

Webster, R. L., Steinhart, M. H., & Senter, M. G. Changes in infants' vocalizations as a function of differential acoustic stimulation. Developmental Psychology, 1970, 7, 39-43.

Weir, R. H. Some questions on the child's learning of phonology. In F. Smith and G. A. Miller (Eds.), The genesis of language. Cambridge, Massachusetts: MIT Press, 1966.

Weisberg, P. Social and non-social conditioning of infant vocalizations. Child Development, 1963, 34, 377-388.

Wilson, W. Sensory assessment: Auditory. Conference on Early Behavioral Assessment of the Communicative and Cognitive Abilities of the Developmentally Disabled, Seattle, Washington, May, 1976.

Winitz, H. Articulatory acquisition and behavior. New York: Appleton-Century-Crofts, 1969.

Yang, R. K., & Bell, R. Q. Assessment of infants. In P. McReynolds (Ed.), Advances in psychological assessment (Vol. 3), San Francisco: Jossey-Bass Publishers, 1975.

References

Ali, L., Gallagher, T., Goldstein, J., & Daniloff, R. Perception of coarticulated nasality. Journal of the Acoustical Society of America, 1971, 49, 538-540.

Barrett-Goldfarb, M. S., & Whitehurst, G. J. Infant vocalizations as a function of parental voice selection. Developmental Psychology, 1973, 8 273-276.

Bates, E., Camaioni, L., & Volterra, V. The acquisition of performatives prior to speech. Merrill-Palmer Quarterly, 1975, 21, 205-226.

Bayley, N. Manual for the Bayley scales of infant development. New York: The Psychological Corporation, 1969.

Belmore, N. G., Kewley-Port, D., Mobley, R. L., & Goodman, V. E. The development of auditory feedback monitoring: Delayed auditory feedback studies on the vocalizations of children aged six months to 19 months. Journal of Speech and Hearing Research, 1973, 16, 709-720.

Bench, J. Some effects of audio frequency stimulation on the crying baby. Journal of Audiological Research, 1969, 9, 122-128.

Berry, M. F., & Eisenson, J. Normal development of speech. In Speech disorders: Principles and practices of therapy. New York: Appleton-Century-Crofts, 1956.

Bever, T. G. Pre-linguistic behavior. Unpublished honors thesis, Department of Linguistics, Harvard University, 1961.

Birns, B., Blank, M., Bridger, W. H., & Escalona, S. K. Behavioral inhibition in neonates produced by auditory stimuli. Child Development, 1965, 36, 639-645.

Blair, F. X. Language Evaluation Scale. Unpublished manuscript available from Department of Special Education, The University of Wisconsin, Milwaukee, undated.

Bloom, K. Social elicitation of infant vocal behavior. Journal of Experimental Child Psychology, 1975, 20, 51-58.

Bloom, K., & Esposito, A. Social conditioning and its proper control procedures. Journal of Experimental Child Psychology, 1975, 19, 209-222.

Bloom, L. Language development: Form and function in emerging grammars. Cambridge: M.I.T. Press, 1970.

Bloom, L. Talking, understanding and thinking. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974, in press.

Boone, D. R. Infant speech and language development. Volta Review, 1965, 62, 414-419.

Bowerman, M. Early syntactic development: A cross-linguistic study with special references to Finnish. Cambridge, England: Cambridge University Press, 1973.

Bricker, W., & Bricker, D. Early language intervention. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Brown, R. Words and things. Glencoe, Illinois: The Free Press, 1958.

Brown, R. A first language: The early stages. Cambridge: Harvard University Press, 1973.

Butterfield, E. C., & Cairns, G. F. The infant's auditory environment. In T. J. Tjossem (Ed.), Intervention strategies for high risk infants and young children. In press, 1976.

Butterfield, E. C., & Siperstein, G. N. Influence of contingent auditory stimulation upon non-nutritional suckle. In J. Bosma (Ed.), Oral sensation and perception: The mouth of the infant. Springfield, Illinois: C. C. Thomas, 1972.

Pzoch, K. R., & League, R. Assessing language skills in infancy. Gainsville, Florida: The Tree of Life Press, 1971.

Cairns, G. F., & Butterfield, E. C. Assessing infants' auditory functioning. In B. Z. Friedlander, G. M. Sterritt, & G. Kirk (Eds.), Exceptional infant, (Vol. 3). New York: Brunner/Mazel, Inc., 1975.

Cairns, G. F., & Karchmer, M. A. Assessment of infants at-risk for language dysfunction through the use of their speech productions. Paper presented at the meeting of the Council for Exceptional Children, Los Angeles, April, 1975.

Cattell, P. The measurement of intelligence of infants and young children. New York: The Psychological Corporation, 1940.

Chomsky, N. A. A review of B. F. Skinner's Verbal Behavior. Language, 1959, 35, 26-58.

Clark, E. V. What's in a word? On the child's acquisition of semantics in his first language. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Clark, H. H. Space, time, semantics, and the child. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Cole, R. A., & Scott, B. Toward a theory of speech perception. Psychological Review, 1974, 81, 348-374.

Collen, J. K., Fargo, N., Chase, R. A., & Baker, P. The development of auditory feedback monitoring: I. Delayed auditory feedback studies on infant cry. Journal of Speech and Hearing Research, 1968, 11, 85-93.

Condon, W. S., & Sander, L. W. Synchrony demonstrated between movements of the neonate and adult speech. Child Development, 1974, 45, 456-462.

Crystal, D. Linguistic mythology and the first year of life. An edited version of the sixth Jansson Memorial Lecture. British Journal of Disorders of Communications, 1973, 8(1), 29-36.

D'Asaro, M. J., & John, U. A rating scale for evaluation of receptive, expressive, and phonetic language development in the young child. Cerebral Palsey Review, 1961, 22, 17-19.

Dodd, B. J. Effects of social and vocal stimulation on infant babbling. Developmental Psychology, 1972, 7, 80-83.

Eilers, R. E., & Minifie, F. D. Fricative discrimination in early infancy. Journal of Speech and Hearing Research, 1975, 18, 158-167.

Eimas, P. D. Auditory and linguistic processing of articulation by infants. Perception and Psychophysics, 1974, 16, 513-521.

Eimas, P. D. Auditory and phonetic coding of the cues for speech: Discrimination of the (r-l) distinction by young infants. Perception and Psychophysics, 1975, 18, 341-347.

Eimas, P. D., Siqueland, E. R., Jusczyk, P., & Vigorito, J. Speech perception in infants. Science, 1971, 171, 303-306.

Eisenson, J., Jeffery, J. J., & Irwin, J. V. The development of speech in the child: First sounds to first words. The psychology of communication, New York: Appleton-Century-Crofts, 1963.

Ervin-Tripp, S. M. Language development. In L. W. Hoffman, & M. L. Hoffman (Eds.), Review of child development. New York: Russell Sage Foundation, 1966.

Fischer-Jorgenson, E. Perceptual studies of Danish stop consonants. Copenhagan, Denmark: University of Copenhagen, Institute of Phonetics, Annual Report VI, 1972.

Fodor, J. A., Garrett, M. F., & Brill, S. L. The perception of speech sounds by pre-linguistic infants. Perception and Psychophysics, 1975, 18, 74-78.

Fokes, J. Developmental scale of language acquisition. In B. Stevens (Ed.), Training the developmentally young. New York: John Day Co., 1971.

Fouts, G. T. Elimination of an infant's crying through response prevention. Perception and Motor Skills, 1974, 38, 225-226.

Friedlander, B. Z. The effect of speaker identity, voice, inflection, vocabulary, and message redundancy on infants' selection of vocal reinforcement. Journal of Experimental Child Psychology, 1968, 6, 443-459.

Friedlander, B. Z. Receptive language development in infancy: Issues and problems. Merrill-Palmer Quarterly, 1970, 16, 7-51.

Fry, D. B. The development of the phonological system in the normal and the deaf child. In F. Smith and G. Miller (Eds.), The genesis of language. Cambridge, Massachusetts: M. I. T. Press, 1966.

Fulton, R. T. (Ed.), Auditory stimulus-response control. Baltimore: University Park Press, 1974.

Greenfield, P., Nelson, K., & Saltzman, E. The development of rule-bound strategies for manipulating seriated cups: A parallel between action and grammar. Cognitive Psychology, 1972, 3, 291-310.

Gross, P., & Cohen, M. Developmental pinpoints. Unpublished manuscript, Experimental Education Unit, Seattle: University of Washington, 1975.

Harris, C. M. A study of the building blocks in speech. Journal of Acoustical Society of America, 1953, 25, 962-969.

Haugan, G. M., & McIntire, R. W. Comparisons of vocal imitation, tactile stimulation, and food as reinforcers for infant vocalizations. Developmental Psychology, 1972, 6, 201-209.

Hecox, K., & Galambos, R. Brain stem auditory evoked responses in human infants and adults. Archives of Otolaryngology, 1974, 99, 30-33.

Hively, W. Domain-referenced testing: Part one. Educational Technology, 1974, 14, 5-10.

Hobbs, N. The futures of children. San Francisco: Jossey-Bass Publishers, 1975.

Irwin, O. C. Infant speech: Consonant sounds according to manner of articulation. Journal of Speech Disorders, 1947, 12, 402-404.

Irwin, O. C. Infant speech: Consonantal sounds according to place of articulation. Journal of Speech Disorders, 1947, 12, 397-401. (b)

Irwin, O. C. The meaningless cries of babies fall into some remarkably meaningful patterns, the study of which shows differences among girls and boys and children of various environments. Scientific American, 1949, 181, 22-24.

Irwin, O. C., & Chen, H. P. A reliability study of speech sounds observed in the crying of newborn infants. Child Development, 1941, 12, 351-368.

Irwin, O. C., & Chen, H. P. Development of speech during infancy: Curve of phonemic types. Journal of Experimental Psychology, 1946, 36, 431-436.

Jakobson, R. Child language, aphasia and phonological universals. The Hague: Mouton, 1968.

Jenson, P. J., Williams, W. N., & Rzoch, K. R. Preference of young infants for speech versus non-speech stimuli. Paper presented at the Annual Meeting of the American Speech and Hearing Association, Las Vegas, Nevada, November, 1975.

Jerger, J. Handbook of clinical impedance audiometry. Dobbs Ferry, New York: Morgan Press, 1975.

Jones, S. J., & Moss, H. A. Age, state and maternal behavior associated with infant vocalizations. Child Development, 1971, 42, 1039-1051.

Kahn, J. V. Relationship of Piaget's sensorimotor period to language acquisition of profoundly retarded children. American Journal of Mental Deficiency, 1975, 79, 640-643.

Keith, R. W. Impedance audiometry with neonates. Archives of Otolaryngology, 1973, 97, 465-467.

Keith, R. W. Middle ear function in neonates. Archives of Otolaryngology, 1975, 101, 376-380.

Kuhl, P. K. Perceptual predispositions for the acquisition of speech-sound categories: A comparison of human infants and animals. Seattle, Washington: Conference on Early Behavioral Assessment of the Communicative and Cognitive Abilities of the Developmentally Disabled, May, 1976.

Kuhl, P. K., & Miller, J. D. Speech perception in early infancy: Discrimination of speech-sound categories. Journal of the Acoustical Society of America, 1975, 58, 556.

LaRiviere, C., & Winitz, H. The syllable as perceptual unit? Paper presented at the meeting of the American Speech and Hearing Association, Washington, D. C., October, 1975.

Lasky, R. E., Syrdal-Lasky, A., & Klein, R. E. VOT discrimination by four-to-six-and-a-half month old infants from Spanish environments. Journal of Experimental Child Psychology, 1975, 20, 215-225.

Leavitt, L. A., & Morse, P. A. Research Status Report. Madison, Wisconsin: University of Wisconsin, Infant Development Laboratory, 1975, 1-361.

Lenneberg, E. H. Speech as a motor skill with special reference to non-aphasic disorders. Monographs of the Society for Research in Child Development, 1964, 29, No. 92, 115-127.

Lenneberg, E. H. Biological Foundations of Language. New York: John Wiley & Sons, 1967.

Lenneberg, E. H. Of language, knowledge, apes, and brains. Journal of Psycholinguistic Research, 1971, 1, 1-29.

Lenneberg, E. H., Rebelsky, F. C., & Nichols, I. A. The vocalizations of infants born to deaf and to hearing parents. Human Development, 1965, 8, 23-37.

Lewis, J., Daniloff, R., & Hammarberg, R. Apical coarticulation at juncture boundaries. Journal of Phonetics, 1975, 3, 1-7.

Liberman, A. M., Cooper, F. S., Shankweiler, D., & Studdert-Kennedy, M. Perception of the speech code. Psychological Review, 1967, 74, 431-461.

Lloyd, L. L. The assessment of auditory abilities. Paper presented at the Fourth International Congress of the International Association for the Scientific Study of Mental Deficiency, Washington, D. C., August, 1976.

MacNamara, J. Cognitive basis of language learning in infants. Psychological Review, 1972, 79, 1-13.

McNeil, P. The development of language. In P. H. Mussen (Ed.), Carmichael's Manual of Child Psychology. New York: John Wiley & Sons, 1970.

Margolis, R. H., & Popelka, G. R. Static and dynamic acoustic impedance measurements in infant ears. Journal of Speech and Hearing Research, 1975, 18, 435-455.

Massaro, D. W. Perceptual images, processing time and perceptual units in auditory perception. Psychological Review, 1972, 79, 124-145.

Mavilya, M. P. Spontaneous vocalization and babbling in hearing impaired infants. Unpublished doctoral dissertation, Columbia University, 1969.

Mavilya, M. P. Spontaneous vocalization and babbling in hearing impaired infants. In C. Fant (Ed.), International symposium on speech communication, ability, and profound deafness. Washington, D. C.: Alexander Graham Bell Association for the Deaf, 1972.

Menyuk, P. Speech pathology: Some principles underlying theraputic practices. Paper presented at American Speech & Hearing Association Convention, 1968.

Mermelstein, P. Automatic segmentation of speech into syllabic units. Journal of the Acoustic Society of America, 1975, 58, 880-883.

Moffitt, A. R. Consonant cue perception by twenty- to twenty-four-week-old infants. Child Development, 1971, 42, 717-731.

Morse, P. A. The discrimination of speech and nonspeech stimuli in early infancy. Journal of Experimental Child Psychology, 1972, 14, 477-492.

Morse, P. A. Infant speech perception: A preliminary model and review of literature. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspective--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Mowrer, O. H. Speech development in the young child: 1. The autism theory of speech development and some clinical applications. Journal of Speech and Hearing Disorders, 1952, 17, 263-268.

Myklebust, H. R. Babbling and echolalia in language theory. Journal of Speech and Hearing Disorders, 1957, 22, 356-360.

Ohman, S. E. G. Coarticulation in VCV utterances: Spectographic measurements. Journal of the Acoustical Society of America, 1966, 39, 151-168.

Pennypacker, H. S., Koenig, C. H., & Lindsley, O. R. Handbook of the Standard Behavior Chart. Kansas City, Kansas: Precision Media, 1972.

Premack, D., & Premack, A. J. Teaching visual language to apes and language-deficient persons. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives—acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Ramey, C. T., & Ourth, I. Delayed reinforcement and vocalization rates of infants. Child Development, 1971, 42, 291-297.

Ramey, C. T., Collier, A. M., Sparling, J. J., Loda, F. A., Campbell, F. A., & Ingram, D. L. The Carolina Abecedarian Project: A longitudinal and multidisciplinary approach to the prevention of developmental retardation. Paper presented at PCMR ACEI National Conference on Early Intervention with High Risk Infants and Young Children, Chapel Hill, North Carolina, May, 1974.

Rheingold, H. L., Gewirtz, J. L., & Ross, H. W. Social conditioning of vocalizations in the infant. Journal of Comparative and Physiological Psychology, 1959, 52, 68-73.

Roe, K. V. A longitudinal study of infant vocalizations. Unpublished doctoral dissertation, University of California, Los Angeles, 1968.

Roe, K. V. Amount of infant vocalization as a function of age: Some cognitive implications. Child Development, 1975, 46, 936-941.

Routh, D. K. Conditioning of vocal response differentiation in infants. Developmental Psychology, 1969, 1, 219-226.

Rubin, D. C. The subjective estimation of relative syllable frequency. Perception and Psychophysics, 1974, 16, 193-196.

Sander, E. K. How significant is a baby's babbling? Elementary English, 1969, 15, 80-84.

Savin, H. B., & Bever, T. G. The non-perceptual reality of the phoneme. Journal of Verbal Learning and Verbal Behavior, 1970, 9, 295-302.

Schlesinger, I. M. Production of utterances and language acquisition. In D. I. Slobin (Ed.), The ontogensis of language. New York: Academic Press, 1971.

Schlesinger, I. M. Relational concepts underlying language. In R. L. Schiefelbusch and L. L. Lloyd (Eds.), Language perspectives--acquisition, retardation, and intervention. Baltimore, Maryland: University Park Press, 1974.

Sheppard, W. C. Operant control of infant vocal and motor behavior. Journal of Experimental Child Psychology, 1969, 7, 36-51.

Shultz, T. R., & Zigler, E. Emotional concomitants of visual mastery in in infants: The effects of stimulus movements on smiling and vocalizing. Journal of Experimental Child Psychology, 1970, 10, 390-402.

Siegal, G. M. Vocal conditioning in infants. Journal of Speech and Hearing Disorders, 1969, 34, 3-19.

Simner, M. J. Newborn's response to the cry of another infant. Developmental Psychology, 1971, 5, 136-150.

Sinclair-deZwart, H. Sensori-motor action patterns as a condition for the acquisition of syntax. In R. Huxley and E. Ingram (Eds.), Language acquisition: Models and methods. New York: Academic Press, 1971.

Sinclair-deZwart, H. Some remarks on the Genevan point of view on learning with special reference to language. In L. L. Hinde and H. C. Hinde (Eds.), Constraints on learning. New York: Academic Press, 1973.

Skinner, B. F. Verbal Behavior. New York: Appleton-Century-Crofts, Inc., 1957.

Slobin, D. I. Cognitive prerequisites for the development of grammar. In C. A. Ferguson and D. I. Slobin (Eds.), Studies of child language development. New York: Holt, Rinehart and Winston, 1973.

Staats, A. W. Linguistic-mentalistic theory versus an explanatory S-R learning theory of language development. In D. I. Slobin (Ed.), The ontogenesis of grammar. New York: Academic Press, 1971.

Stark, R. E., Rose, S. N., & McLagen, M. Features of infant sounds: The first eight weeks of life. Journal of Child Language, 1975, 2, 205-222.

Streeter, L. Language perception of 2-month-old infants shows effects of both innate mechanisms and experience. Nature, 1976, 259, 39-41.

Sweeney, S. The importance of imitation in the early stages of speech acquisition. A case report. Journal of Speech and Hearing Disorders, 1973, 38, 490-494.

Telford, C. W., & Sawrey, T. M. The exceptional individual: Psychological and Educational Aspects. Englewood, Cliffs, New Jersey: Prentice Hall, 1967.

Tischler, H. Schreien, lallen und erstes sprechen in der entwicklung des sauglings. Zeitschrift Fur Psychologie Mit Zeitschrift Fuer Angewandte Psychologie, 1957, 160, 210-263.

Todd, G. A., & Palmer, B. Social reinforcement of infant babbling. Child Development, 1968, 39, 592-596.

Tomlinson-Keasey, C. Conditioning of infant vocalizations in the home environment. Journal of Genetic Psychology, 1972, 120, 75-82.

Trehub, S. E. Auditory-linguistic sensitivity in infants. Unpublished doctoral dissertation, McGill University, 1973.(a)

Trehub, S. E. Infants' sensitivity to vowel and tonal contrasts. Developmental Psychology, 1973(b), 9, 91-96.

Treon, M. A. Fricative and plosive perception-identification as a function of phonetic context in CVCVC utterance. Language and Speech, 1970, 13, 54-64.

Turnure, C. Response to voice of mother and stranger by babies in the first year. Developmental Psychology, 1971, 4, 182-190.

Uzgiris, J. C., & Hunt, J. McV. Assessment in infancy: Ordinal scales of psychological development. Chicago: University of Illinois Press, 1975.

Webster, R. L. Selective suppression of infants' vocal responses by classes of phonemic stimulation. Developmental Psychology, 1969, 1, 410-414.

Webster, R. L., Steinhart, M. H., & Senter, M. G. Changes in infants' vocalizations as a function of differential acoustic stimulation. Developmental Psychology, 1970, 7, 39-43.

Weir, R. H. Some questions on the child's learning of phonology. In F. Smith and G. A. Miller (Eds.), The genesis of language. Cambridge, Massachusetts: MIT Press, 1966.

Weisberg, P. Social and non-social conditioning of infant vocalizations. Child Development, 1963, 34, 377-388.

Wilson, W. Sensory assessment: Auditory. Conference on Early Behavioral Assessment of the Communicative and Cognitive Abilities of the Developmentally Disabled, Seattle, Washington, May, 1976.

Winitz, H. Articulatory acquisition and behavior. New York: Appleton-Century-Crofts, 1969.

Yang, R. K., & Bell, R. Q. Assessment of infants. In P. McReynolds (Ed.), Advances in psychological assessment (Vol. 3), San Francisco: Jossey-Bass Publishers, 1975.